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# ROQUEMAURE

# TOWNSHIP

Abitibi-West County

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GEOLOGICAL REPORT–150

P.R. EAKINS

1972

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## ABSTRACT

The Archean bedrock of Roquemaure Township, which forms part of the Superior Province of the Canadian Shield, is composed of a complex of rhyolitic lavas, fragmental rocks and small intrusive bodies overlain by a large number of massive and pillowed lava flows mainly of basaltic composition, but accompanied by some andesitic lavas and breccias. Some of the basaltic flows, unusually high in magnesia (MgO up to 19%) and nickel (up to 900 ppm), contain small, well-defined serpentine pseudomorphs after olivine phenocrysts and appear to be related genetically to a sill-like body of serpentinized dunite cropping out in range I.

The volcanic rocks are folded into a broad anticlinal structure with steep to overturned flanks facing west with a steep to vertical plunge; the axial zone of this major fold is disrupted by a northeasterly trending, northerly dipping schist zone, and the northern flank is in part occupied by an elliptical mass of gneissic granite. A major granitic pluton occupies the central part of the structure in the adjoining township to the east.

Numerous bodies of gabbro, diorite, and salic porphyries, of various ages and compositions intersect the volcanic rocks and each other. Faults of various orientations and ages are commonly observed on a small scale, and undoubtedly play an important role in the deformation of the various bedrock units.

The grade of metamorphism is generally low; typically the volcanic rocks are made up of minerals of the greenschist facies. Around the northern gneissic granite the amphibolite facies is present accompanying broad zones of well-defined foliation. Away from the amphibolite zone cleavages and lineations are for the most part conspicuous by their absence even in sections of vertical dips.

Small showings of chrysotile asbestos have been probed by a number of diamond drill holes in range I. A small veinlet of silver mineralization near a northtrending diabase dike in range IX has in the past been explored without encouragement. Pyrite and occasionally chalcopyrite occur as small widespread disseminations in the volcanic and intrusive rocks.

The bedrock is extensively mantled by post-glacial lake clays, some till and fluvio-glacial sands and gravels.

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# INTRODUCTION

During the summer field season of 1968 the township of Roquemaure, County of Abitibi-West, was mapped by the author and R.H. Kimambo on a scale of one inch equivalent to one thousand feet.

The township is located in northwestern Quebec and lies approximately midway between the important copper-gold-zinc deposits of Rouyn-Noranda area to the south and the copper-zinc orebody of Normetal Mining Corp. Ltd., to the north. Rouyn-Noranda and Normetal are separated by a distance of some 60 miles. Deposits of copper, nickel, molybdenum and other metals and minerals occur both to the east of the map-area in Quebec (Dugas, Latulippe, Duquette, 1967) and to the west in Ontario.

The map project was initiated to delineate accurately a major rhyolite-basalt contact indicated in earlier work by Lee (1950) and others in the southern two ranges of the township, and to take advantage of the extensive clearing of the forested land by farmers since earlier mapping in the 1920's and 1930's.

## Location

The township of Roquemaure is bounded on the west by the Ontario-Quebec interprovincial boundary, on the north and south by the townships of La Reine and Hébécourt respectively, and on the east by the township of Palmarolle. The eastern part of Lake Abitibi, a major body of water in the region, forms the most prominent topographic feature within the township, occupying much of its northern half.

The geographic centre of the township is at latitude 48°39' north, and longitude 79°23' west. The population of the widespread farming community occupying the southern half of the township centres around the village of Roquemaure, located at the intersection of the north-south mid-township road and the range II-III road. Roquemaure is about 45 miles by road north of the regional centre of Rouyn-Noranda.

Access

Well-maintained gravel roads provide ready access to all parts of the township from the nearby larger centres of Duparquet, seven miles to the southeast, and La Sarre, ten miles to the north, of the township boundaries. Paved highways connect these centres to the cities of Rouyn-Noranda and Amos.

Roads along the eastern half of the range I-II line of the township, the entire lengths of the II-III and the IV-V range lines, and the westernmost section of the southern boundary of the township, along with several north-south connecting roads along lot lines, serve to make access to all parts of the southern half of the township very easy under practically all weather conditions. Access to many sections away from the all-weather gravel roads is rendered even easier during periods of dry weather, or when the ground is frozen, by numerous farm and lumber tracks but in wet periods they can only be used by farm tractors or heavy-duty four-wheel-drive vehicles.

Lake Abitibi and the swampy drainage basin of the Maine river comprise most of the northern half of the township and farm land is only to be found along two relatively narrow strips — one in the northeastern quarter of the township and the other along the length of Nepawa island in the northwestern quarter. A good gravel road enters the northeastern corner of the township from Ste-Hélène-de-Mancebourg and La Sarre, and sweeps south for two miles, then west across a wooden covered bridge onto Nepawa island, and continues to the west along the range VIII-IX line which is laid out on a bearing of S.86°W.

Most of the rock exposures on the shores of Lake Abitibi, both in the northern half of the township and its southwestern quarter, are most practicably visited by canoe or motor launch. In the southern half of the township, access to the lake is readily gained only at the western end of the Range IV-V line road, which ends only a few feet above lake level at a sandy beach. A beach accessible by private farm road, turning north off the same public road in lot 54 of range V also provides a good launching place. A large canoe or motor launch may also be placed in the water with ease on the Duparquet river at the range II-III road bridge opposite the hamlet of Gallichan, where an old ferry jetty is still in good condition.

In the northern half of the township, ready access to Lake Abitibi is to be found in range IX, approximately at the lot 42-43 line, where there is a jetty, and with somewhat more difficulty at the southeastern end of the bridge onto Nepawa island. Access to the lake is also very easy at the western end of the northern township boundary road in lot 16 where there is a small stone pier.

Travel on Lake Abitibi can at times be hazardous and extreme care must be exercised. The bottom of the lake is highly irregular and shoals and reefs abound. The water is clouded by clay particles and underwater obstacles are practically invisible. Moreover, the lake reaches to the west some 40 miles in the direction of the prevailing winds, and "high seas" may arise quite rapidly and unexpectedly.

## Culture

Dairy and beef cattle farming are carried on extensively throughout the township, and land clearing and ditching operations to drain the clayey soil are still being carried out on many farms. Lumbering, largely of poplar stands for pulpwood, is widespread but on a small scale. Both farming and lumbering operations directly benefit mineral exploration activities, inasmuch as both produce new rock exposures through the removal of forest cover, and provide for ready access and good operating conditions for technical surveys.

Until about 1950 a large band of Indians camped on Indian Cemetery peninsula near the site of an abandoned Hudson Bay Company post. Little evidence of this encampment and its church remain except for a heavily overgrown cemetery and several large clearings.

## Previous Work

The township forms part of the area mapped by Lang and Buffam (1932) on a scale of 1 inch to 1 mile. Their map was made before most of the clearing and drainage was effected by colonist farmers. Cooke, James and Mawdsley (1931) describe the geology of some of the rock units of the township in their study of the Rouyn-Harricanaw region.

B. Lee (1950) mapped ranges I and II of Roquemaure township on a scale of 1 inch to 1,000 feet in 1949 for the Quebec Department of Mines.

The map-area is covered by the Palmarolle Sheet (Map 446) in the Aeromagnetic Series of the Geological Survey of Canada.

## Method of Current Work

The mapping was carried out using aerial photographs taken in 1965, having an approximate scale of 1 inch equivalent to 1,000 feet.

The 100 square-mile township has been surveyed for cadastral purposes in the standard provincial system of east-west ranges 1 mile wide divided into north-south lots of 100 acres each. Because of the extensive tracts of cleared land, the generally gently rolling nature of the terrain, the clearly demarcated range and lot lines, and the excellent quality of the serial photographs, systematic traversing on a grid line basis was unnecessary; all potential areas of outcrop which were visible or suspected on the aerial photographs, by simple visual inspection or by stereoscopic analysis, were visited. Traverses by pace-and-compass methods were run only in a few sections, usually heavily forested, where indications of outcrops were sparse.

Outcrops along the extensive shoreline of Lake Abitibi were examined from canoes or motor launches, as were the numerous islands, islets and bedrock reefs of the lake, and the navigable rivers such as the Maine and the Antoine, and their tributaries, were inspected for rock exposures.

Lithologies were studied in numerous hand specimens and in 78 thin-sections. In addition, 30 samples of common rock types were analyzed by the Laboratories Branch of the Department of Natural Resources: ten major elements and eleven minor elements were determined by atomic absorption and spectrographic techniques.

Acknowledgments

Mr. R.H. Kinambo, an officer of the Geological Survey of Tanzania, on leave in Canada to study mineral exploration techniques at McGill University, ably assisted in the field work and independently carried out a considerable amount of the mapping. Mr. Kimambo is to be commended for his endeavours, particularly since they are carried out entirely on a voluntary basis; the terms of his fellowship from the United Nations precluded his acceptance of any salary from the Department of Natural Resources. Thanks are due to Mr. Patrick Genest of Laval University for his unfailingly cheerful assistance as driver, canoeman, and amanuensis.

I should also like to thank my colleagues at McGill University, Dr. E.H. Kranck and Dr. A.R. Philpotts, for advice and discussion of petrological and petrographic problems. Professor Kranck was especially helpful in assisting the author in microscopic studies.

## PHYSIOGRAPHY

Roquemaure township lies in the "clay belt" of Northwestern Quebec. This "clay belt" forms the Abitibi plain, which arises out of the

extensive deposition of varved clays on the bottom of the once extensive Lake Barlow-Ojibway, a major peri-glacial feature formed during the retreat of the last continental ice sheet, when glacial melt waters were impounded between the retreating glacial mass and the height of land to the south. The present physiography of the township represents the sum total of the effects of 1) a long period of weathering and erosion preceding continental glaciation, 2) glacial erosion and scour, deposition of till of various types and of eskers during the continental glaciation, 3) deposition of peri- and/or post-glaciation varved lake clays and their subsequent differential compaction, and recent, largely lake, erosion of these varved clays.

## Description of Topography and Outcrop Patterns

The present topography of Roquemaure township is flat to gently rolling over most of its extent; only along its southern boundary with Hébécourt township is there a major topographic feature, a ridge rising a hundred feet or more above the surrounding countryside, and forming a natural geographical barrier from the much more rugged area to the south.

Locally, there are steep clay slopes or bedrock cliffs. Exposures of bedrock occur as low to quite prominent knobs, or occasionally as ridges, often with steep northern slopes or cliffs; as scattered outcrops at the base of relatively steep clay slopes, and as annular rings forming the pediments of clay-topped hills and knolls formed by erosion of the glacial lake clays. Exposures are generally scarce as a whole in the township.

## Shoreline Erosion

The shoreline of Lake Abitibi consists of a series of smooth semicircular bays with intervening rocky or bouldery headlands. The bays are usually shored by cliffs of clay from a few feet to 50 feet or more in height, and only rarely by sandy beaches. The headlands are made up of gently sloping to steep-sided outcrops and/or bouldery promontaries. Many of the bays approximate an almost perfect quarter-moon profile, with the tips of the profile defended by outcrops and/or by accumulations of boulders. This unusual type of shoreline results from the easy erosion by wave action of the clay mantle overlying the bedrock or its cover of bouldery till. During the withdrawal of the continental icesheet with its consequent lowering of the dammed lake level, wave action took place at continuously lower levels down to the present one, as Lake Barlow-Ojibway shrank and broke up into numerous smaller units, the largest of which is Lake Abitibi. Earlier shorelines can easily be delineated inland from the present lake shores. Tracing such earlier shorelines usually leads to the discovery of bedrock exposures (or, less desirably, accumulations of boulders), which were formerly bastions protecting the clays from wave erosion. Exposures of bedrock and accumulations of boulders can be expected at the base of clay hills, knolls, and at the cusps of semi-circular steep clay slopes.

## Bedrock Topography as Reflected by the Present Surface

The pre-glacial local topographic relief of the Precambrian bedrock is probably similar to the rugged topographic bedrock relief to be found around the Lake Dufault area north of Noranda. The mantle of clay and till has masked this pre-glacial topography much more effectively than to the south, except, for example, the range I boundary ridge, the long semicircular ridge overlooking the drainage basin of Maine river and Nepawa bay underlain by gneissic granite, and a few other prominent bedrock features which protrude through the glacial cover, as in the eastern sections of ranges IV and V.

Because of the differential compaction the mantle of clays has, however, not entirely masked bedrock trends expressed by the greater ease of weathering and greater erosion of softer rock units, or of fault and shear zones. For example, the swampy basin of the Maine river in range X largely expresses the distribution and shape of the underlying La Reine granite body, which was obviously more readily weathered and eroded than its contact aureole of metamorphosed volcanic rocks. The valley of the Duparquet river probably reflects an earlier river valley, which in turn may have followed a north-south fracture or fault zone; some, if not all, of the smaller rivers and streams in the township similarly appear to reflect bedrock trends.

A line of sand and gravel islands in Lake Abitibi trending N.10°E.in the northeastern quarter of the township probably represents the remnants of a large esker. What appears to be a continuation of this esker runs through the eastern ends of ranges IV and V, and is locally exploited for material for road building and maintenance.

## GENERAL GEOLOGY

Roquemaure township lies along a northwest trending belt of Archean volcanic rocks which extends into Ontario.

The bedrock of the map-area is characterized by an anticlinal zone of deformed rhyolitic to dacitic lavas occupying the east central part of the township. This zone is much complicated on a small scale by a plethora of narrow salic to mafic dikes and sills of diverse ages and orientations, many of which have themselves been deformed by folding and/or faulting. This core of rhyolitic rocks is made up of two units: 1) a complex of rhyolitic lavas and breccias intruded by numerous small salic dikes or sills in the central part and 2) massive rhyolite with some breccia in the outer part.

Plate I - Aerial photograph (65226-163) showing the typical wave erosion pattern developed along the south shore of Lake Abitibi. Clay cliffs of varying height rim the semi-circular bays; accumulations of boulders or the presence of outcrops form the promontories and irregular shorelines. With only a little further erosion the sinuous peninsula shown in the northern part of the photograph will become two or more islands. Scale one inch approximately equivalent to one mile.

The rhyolitic rocks are overlain by a west-northwesterly trending band of pillowed and massive basaltic lava flows with related intrusive bodies. This unit occupies the southern third of the township with steep, vertical to overturned dips and consistent facings to the south in the lavas; it therefore overlies the salic volcanic complex immediately adjoining to the north. The obviously extrusive layers (pillow lavas, flow breccias, etc.) are interlayered with sill-like masses of very fine grained to fine- to medium-grained gabbroic and peridotitic rocks, and by large, medium- to coarse-grained gabbro and diorite masses.

A similar band of pillowed and massive mafic and ultramafic lavas with associated penecontemporaneous gabbroic sills and dikes trends northeasterly in the north part of the area. The lava layers dip steeply and face north. This band probably represents the northern equivalent of the southern basaltic zone. The rocks of the northern band are intruded by later salic and mafic dikes and sills.

Peridotite, gabbro and diorite form elongated intrusive bodies more or less along the trend of the volcanic formations. Granitic intrusions include the La Reine granite and the more recent Nepawa granodiorite and Palmarolle granite. The granitic intrusions are accompanied by migmatization (generally local) and amphibolitization (generally more widespread), to varying degrees.

Small salic and mafic dikes, lamprophyre and diabase dikes are the last intrusions. The sedimentary rocks do not form mappable units and are restricted to some thinly layered cherty xenoliths in gabbro or fragments in volcanic breccias, to minor beds of iron-formation and tuffaceous layers.

TABLE I

TABLE OF FORMATIONS

| | | |
|---|---|---|
| CENOZOIC | RECENT AND PLEISTOCENE | Forest soils; sand and gravel deposits, glacial lake varved clays; fluvio-glacial sands and gravels; till and eskers |
| PRECAMBRIAN | LATE | Diabase dikes |
| | EARLY | Lamprophyre and small salic and mafic dikes<br>Palmarolle granite and related rocks<br>Nepawa granodiorite |
| | | Folding and Faulting |
| | | La Reine granite<br>Late dioritic and gabbroic dikes, late feldspar porphyry dikes<br>Gabbros and diorites, Roquemaure gabbro |
| | | Folding and Faulting |
| | | Intrusions related to volcanic rocks:<br>- Gabbro, peridotite-dunite and serpentinite, red chert gabbro<br>- Rhyolite porphyry, and related dikes<br>Basaltic volcanic rocks, minor tuff and andesite with amphibolitized equivalents<br>Rhyolitic to dacitic lavas, minor sedimentary and pyroclastic rocks |

## Nomenclature

The nomenclature with regard to the classification of volcanic rocks, and many associated intermediate to basic intrusive rocks in the Superior Province of northwestern Quebec and Ontario, has grown up upon the basic of a colour coding: brown-weathering, dark green lavas have traditionally been called "andesites"; buff to light green weathering, light green to gray lavas, "dacites"; and white-weathering, light to dark coloured lavas, "rhyolites"; brown to buff weathering light green to dark green intrusive rocks have generally been called "diorites", the term "gabbro" being reserved for the more melanocratic intrusive rock. This classification has arisen of necessity, because, particularly in the case of the lavas, the rocks are too fine grained, or too affected by regional metamorphism, albeit generally only in the mild greenschist facies, to be classified mineralogically on the basis of microscopic examination of thin sections of the rocks. Only in the last decade with the development of cheap methods of chemical analysis and consequently the greater frequency of chemical determinations has it become possible to arrive at a correct nomenclature. In general the field designations tended to be too much on the salic side mineralogically or acidic side chemically. Most andesites are therefore in fact basaltic in composition, etc., and most diorites gabbroic.

In the present study the "andesites", "dacites" and "rhyolites" proved overall to be much more basic in chemical composition than had been envisioned in the field. Furthermore, many of the basaltic rocks have a high content of magnesia and nickel, and may represent a distinctive volcanic assemblage. It should be noted here that Anhaeusser et al., (1968) predicted the occurrence in the Canadian Shield of high magnesia-nickel lava ultramafic assemblages on the basis of their compilatory studies of the volcanic lithologies of the Archean terrains of southern Africa and western Australia.

The proper rock names, based on chemical composition, are used in this report.

Some amplification is required on the usage of the terms ultrabasic, ultramafic, salic, felsic, acidic, basic etc. Specifically the term ultramafic applies to mineralogical classification whereas the term ultrabasic refers to chemical composition: rocks described as ultramafic are those with a colour index of more than 70, that is to say, rocks containing more than 70% of mafic minerals such as olivine, pyroxene, hornblende, biotite, phlogopite, serpentine, and the opaque minerals (Wyllie, 1967). Ultrabasic rocks, on the other hand, are those containing not more than 45% $SiO_2$. Most ultrabasic rocks are also ultramafic, and vice versa, but exceptions exist. The lavas of Roquemaure of basic and mafic affinities must be so labelled, and in general can be called picritic basalts and basalts.

A further note on nomenclature is that during the mapping and throughout the report, unless a fine-grained igneous rock unit shows distinctive features of an extrusive origin, it is not labelled as a lava, but is considered to be intrusive. It is recognized, of course, that by such a policy of nomenclature, a considerable amount of material will be included in the intrusive category although it may be extrusive, and form part of large massive lava flows. The difference between a lava flow and a penecontemporaneous sill injected but a few feet or a few tens of feet below the surface, can be considered largely academic, although the distinction between such a sill and a later one perhaps devoid of genetic relationships with the enclosing lavas may be important.

## VOLCANIC ROCKS

The supracrystal rocks of Roquemaure township fall into two lithologically distinct volcanic categories: an earlier salic, rhyolitic to dacitic lava complex, and a later, mafic to ultramafic, andesitic to basaltic sequence of lava flows. Lithological types abound, in large part because of the various degrees in metamorphism, from simple devitrification of originally glassy lava flows, through low grade but pervasive regional metamorphism, which is generally prevalent, to a contact metamorphism of the amphibolite facies somewhat sporadically developed around the larger granitic bodies. Most of the volcanic rocks, although they are presumably among the oldest rocks within the Canadian Shield, are remarkably fresh.

The intrusive lithology is extremely varied in composition and texture ranging chemically from dunite to granite, and in texture from aphanitic felsite to pegmatoid gabbro.

In most cases examination of volcanic rocks under the microscope provided few clues to the composition of the rock because of the very fineness of the minerals present in grains so small as to make rigorous determination, and modal analysis, all but impossible. Regional metamorphism has produced an assemblage of rocks made up of quartz, plagioclase,carbonate, white mica, talc, magnetite, etc., in varying but ill-defined amounts which cannot be resolved microscopically. As mentioned earlier, the field designations of most rocks were generally too salic and the proper name was derived from chemical analyses.

The secrets of the volcanic stratigraphy of northwestern Quebec, and therefore possibly the discovery of the location of mineral deposits which are restricted to particular stratigraphic horizons or units may well be in the future provided by chemical analyses.

## Rhyolitic to Dacitic Volcanic Rocks

### General Distribution

Rhyolitic to dacitic lavas and related intrusive rocks form a roughly triangular area with the base of the triangle along the eastern boundary of the area from range I to range VII and the apex near the western end of the township centre line. Clear-cut major contacts, except with the Palmarolle granite mass, are not in evidence.

Within this triangular area there is a confusing variety of rock types because of the variations normally found in rhyolitic accumulations and also, more importantly, because of a considerable variation in the development of cleavages and schistosities, and locally the injection of an immense number of tabular igneous bodies of various ages. Very crudely the triangular area may be divided into three parts: a northeasterly trending band of schistose rhyolite, about one mile wide, extending from an apex; an arbitrarily defined, more or less semi-circular sector in the eastern halves of ranges IV to VI, consisting of a complex of flows and intrusive rocks; and the remainder of the triangle largely occupied by rhyolitic breccias.

### Associations and Relationships

The overall structure and age relationships of the rhyolitic volcanic rocks are unknown, because of structural complexity, a paucity of representative bedding determinations, a lack of top-bottom evidence, and the presence of numerous salic and mafic dikes and sills. It seems safe to conclude from the numerous top determinations in nearby pillowed lavas that the rhyolitic rocks lie under the pillowed formations, apparently more or less conformably. The contact between these two major volcanic rock types is not clearly exposed and contact relations are complicated by the presence of volcanic breccias of intermediate composition, and numerous dikes and sills of gabbroic composition. The main southwestern contact of the rhyolite massif shown on the map is, of necessity, largely conjectural because of a lack of outcrop; it appears to diverge in trend about 15 to 20 degrees locally from the trends in overlying rocks. As all the overall volcanic units dip vertically, or nearly so, the map in effect represents a section through the volcanic pile. The contact trend may be interpreted, at least in part, as the slope, inclined in a northeasterly direction, of the original rhyolite volcanic edifice which was slowly surrounded and covered by the later and more fluid basaltic lava flows.

The northwestern contact between the rhyolitic rocks and the amphibolitized basalts to the north is covered by the waters of Lake Abitibi or, in ranges V and VI, by glacial lake clays. The rhyolites exposed along the general contact zone are strongly schistose with dips of schistosity as low as 35 degrees to the north-northwest. The pillowed

basalts along the general contact zone are, on the other hand, massive and amphibolitized but not schistose. Whether the rhyolite-basalt contact is a normal one or not is unknown: it may well be severely disrupted by faulting.

Primary Structures of the Rhyolitic (Salic) Volcanic Rocks

The most obvious feature of most of the rhyolitic material is its fragmental make-up: angular, subangular, or rounded to streaky or shredded fragments occur in groundmasses of similar or different composition. The compositional differences between fragments and their groundmass differ from slight to gross; from obvious flow breccias through incorporation breccias to possible agglomerates. True rhyolitic lava flows are difficult to identify; most of the units appear to be submarine volcanoclastic flows of various types (see Thorton, 1964).

The study of the rhyolitic rocks has been rendered much more difficult by relatively mild but pervasive regional metamorphism involving the development of white mica, chlorite, and carbonate grains as secondary alteration products on a fine to very fine grained scale. Whereas post-glacial weathering brings out mineral contrasts in many of the more mafic rocks in the township, and in the gabbros in particular, in the rhyolitic terrain differential weathering has often not taken place and highly variable mineral compositions are not reflected in outcrops which are, moreover, effectively camouflaged by an ubiquitous lichen coating.

The main rhyolite mass is made up of fragmental rocks which are largely flow breccias and/or incorporation breccias, in varying degrees of development locally. By incorporation breccia is meant the engulfment of fragments on the existing surface by an advancing lava flow, so that the resulting rock is a conglomeration of its own flow breccia, or broken-up crust, and any fragments it may overwhelm and incorporate during its advance.

No evidence in the field or laboratory study indicates the presence of welded tuffs or ignimbrites in the rhyolite succession, and indeed the clear-cut evidence of the presence of any tuffs in the field is scant. The indications are for submarine volcanism, however, and therefore normal welded tuffs or ordinary tuffs probably should not be excepted. Rhyolitic lava which is normally turgid and viscous was being erupted underwater; it is also highly explosive and given to the formation of nuées ardentes, but all the known characteristics of terrestrial rhyolitic volcanism would be strongly modified by a water cover.

Obvious flow layering, usually contorted to highly contorted, can be seen in many places in the rhyolitic section of the township; small folds are not uncommon. Some of the contortions and folds are probably primary, but others with associated schistosities belong to a period or periods of subsequent tectonic deformation.

The clearly identifiable lavas are laced through with massive lithotypes, some of which are undoubted penecontemporaneous sills as should be expected; on the other hand, some of the massive felsic bodies cut deformed lavas and their related massive equivalents and are obviously postvolcanic; they may themselves be involved in later deformation.

Secondary Structures, Alterations, and Metamorphism

A well-developed schistosity is very evident in island outcrops and in many exposures on the south shore of Lake Abitibi along the township centre line; in several places a later cross-fracturing and warping can be observed. In part these occurrences reflect an east-northeast zone of schistosity dipping northerly at 35 to 70 degrees, which is largely covered by the waters of Lake Abitibi. Differential erosion from wave action has made the schistosity observable on the shores.

A massive white-weathering rhyolite porphyry in the eastern rhyolite complex consistently shows two sets of "wispy" cleavage. The "wispy" zones are 4 to 6 inches apart, average about 1 inch thick and are composed of schistose material. One set trending N.30°W. intersects the second set usually at about 10 degrees off the normal. Adjoining rhyolitic breccias usually do not show these cleavages.

In a number of exposures, small folds can be observed, but whether, as noted previously, these are primary and due to flowage, or secondary, could not be determined with any certainty, because they were all poorly exposed.

Carbonatization is strong in a number of reef outcrops in the eastern half of range VI. Weak, ill-defined zones of pyritization are usually noted near small faults or fractures.

The rhyolitic rocks have all been metamorphosed to the greenschist facies.

Lithological Types

Rhyolite and rhyodacite breccias prevail as the most common clearly effusive lithological varieties. These breccias typically weather buff to white in colour, show a light grey to olive-green fresh surface, and contain distinctive fragments commonly several inches to a foot long, but occasionally ranging up to several feet or more in length. Such breccias are well exposed along a prominent rocky ridge in lots 15 and 16 of range V.

A typical rhyolitic fragmental rock occurs in lot 51, range IV, as a white-weathering, cream and grey, irregular, porphyritic flow breccia, or agglomerate, containing numerous fine seriate quartz "eyes" and tiny specks of reddish brown carbonate. The commonest variety of fragment is angular in

shape, from an inch to a foot or more in length, and is composed of an aphanitic porphyry with tiny quartz "eyes"; occasional angular red chert fragments occur widely scattered throughout the rock, which is poorly layered. It is clearly intruded by a later felsic dike along an irregular, blocky contact.

Under the microscope this rock is seen to be composed of numerous angular to rounded quartz "eyes" and grains showing a wide range in size, and scattered to locally abundant sericitized and carbonatized plagioclase phenocrysts, all set in a very fine grained groundmass of quartz, white mica, albite and chlorite with scattered ankeritic carbonate and magnetite grains. One fragment is clearly amygdaloidal.

Overall the fragments and the groundmass of this rock are very similar in appearance and probably in composition, and the rock is considered to be a flow breccia. The extraneous fragments, mostly of red chert, were probably picked up by the rhyolitic lava as it advanced.

Specimen No. 3 (Table 2) was taken in the center of lot 15, range V, for chemical analysis as a more or less typical "rhyolite" flow breccia. The rock weathers to a cream to white coloured surface, shows bluish grey to medium grey coloured fresh surfaces and is clearly fragmental; the lighter coloured streaky fragments up to two or more inches in length are set in a darker bluish grey groundmass. Both the fragments and the groundmass are fine grained and porphyritic; as a whole the rock shows a crude layering cut by a weak fracture cleavage. Microscopic examination reveals a more or less overall homogeneous mineral composition: scattered, mildly altered, equant to lath-shaped oligoclase phenocrysts up to 1 mm. in size, accompanied by occasional large irregular quartz "eyes" and epidote grains set in a very fine grained groundmass of quartz, plagioclase, very fine white mica and magnetite, with scattered tiny grains of epidote and some carbonate and chlorite. From its mineral composition the rock would appear to be more mafic than a typical rhyolite, and examination of its chemical analysis confirms that it is a dacite. Chemically it is quite close in composition to Wilson et al.'s average of three Archean dacites (No. A. Table 3)

TABLE 2

Semi-Quantitative Chemical
Analysis of Rhyolites and Rhyodacites

| | 1 | 2 | 3 |
|---|---|---|---|
| $SiO_2$ | 71.89% | 68.85% | 61.32% |
| $TiO_2$ | 0.45 | 0.49 | 0.95 |
| $Al_2O_3$ | 10.65 | 13.36 | 15.42 |
| CaO | 0.37 | 2.51 | 3.07 |
| MgO | 2.17 | 1.10 | 2.51 |
| FeO* | 9.71 | 5.73 | 8.10 |
| $Na_2O$ | 0.07 | 3.50 | 5.85 |
| $K_2O$ | 1.60 | 1.82 | 0.35 |
| V | 0.008 | 0.005 | 0.008 |
| Cr | 0.007 | 0.002 | 0.005 |
| Fe (total) | 7.55 | 4.44 | 6.28 |
| Ni | 19 ppm | 17 ppm | 31 ppm |
| Zn | 48 " | 75 " | 140 " |
| Cu | 37 " | 32 " | 64 " |
| Pb | 8 " | 12 " | 12 " |

* original determination was for total iron. For purposes of calculation and comparison total iron has been converted entirely to FeO.

1 Rhyolitic tuff from a road cut exposure on the south side of the range road in lot 26, range V, immediately north of the range IV-V line of Roquemaure twp. (Analysis by Laboratory Branch, Q.D.N.R.)

2 Schistose rhyodacite flow breccia from a clean shoreline outcrop under a low clay cliff on the west side of a small peninsula on the south side of Lake Abitibi in lot 31, range VI close to the centre point of Roquamaure township. (Analysis by Maboratory Branch, Q.D.N.R.)

3 Dacite flow breccia from a shoreline exposure in the south-eastern corner of a small bay on the south side of Lake Abitibi in the middle of lot 15, range V, of Roquemaure Twp. (Analysis by Laboratory Branch, Q.D.N.R.)

TABLE 3

Some Average Composition of Archean
Dacites, Rhyodacites, and Rhyolites

| | A | B | C |
|---|---|---|---|
| $SiO_2$ | 61.74% | 67.16% | 74.11% |
| $TiO_2$ | 1.20 | 0.46 | 0.14 |
| $Al_2O_3$ | 15.17 | 16.73 | 13.59 |
| $Fe_2O_3$ | 1.87 | 0.89 | 0.64 |
| FeO | 5.74 | 2.77 | 1.27 |
| MgO | 2.30 | 1.86 | 1.04 |
| CaO | 4.80 | 3.29 | 0.60 |
| $Na_2O$ | 3.57 | 2.61 | 2.74 |
| $K_2O$ | 0.54 | 1.31 | 3.82 |
| $H_2O$ | 1.87 | 0.86 | 0.90 |
| $CO_2$ | 0.47 | 0.24 | 0.51 |
| MnO | 0.14 | 0.02 | 0.02 |
| $P_2O_5$ | 0.32 | 0.12 | 0.12 |
| | 99.73 | 99.33 | 99.50 |

A - Average of 3 Archean dacites
B - Average of 3 Archean rhyodacites
C - Average of 24 Archean rhyolites
(all from Wilson et al., 1965, p. 167)

An example of a rhyodacite flow breccia was taken for analysis (No. 2, Table 2) from an extremely clean, glacially smoothed and polished outcrop, only recently exposed by wave erosion of covering clays, on the south shore of Lake Abitibi in lot 31, range VI. The fragmental nature of the rock in the massive-looking, brownish green and olive drab exposure is only revealed by thoroughly wetting the rock surface. In the main the rock is a smooth buff to white weathering, brownish grey, tough, fine-grained, schistose flow breccia with scattered white feldspar phenocrysts. Under the microscope the phenocrysts are seen to have been completely rolled out by deformation and strongly sericitized. They are set in a finely schistose fragmental groundmass of quartz, white mica, magnetite, carbonate and chlorite, which is cut by thin quartz veinlets. The chemical analysis reveals the rhyolitic nature of the rock which may be classified as a schistose rhyodacite flow breccia.

Massive rhyolite lava flows may well be present in the succession of salic lavas, but none were positively identified in the field. An occurrence in lot 51, range IV, of an extremely fine grained feldspar porphyry, which is clearly intruded by another porphyry, may well represent a massive rhyolitic to dacitic lava. The rock weathers white, is greenish grey in colour, and consists of small (1 mm.) carbonatized plagioclase phenocrysts and occasional streaks of chlorite, or chlorite and magnetite, grains in an extremely fine grained felsic matrix.

A somewhat similar massive feldspar porphyry in lot 51, range IV, may also be a massive salic lava. This rock is light grey to fawn weathering, light greenish grey in colour, and is a rather irregular fine-grained porphyritic aggregate of scattered feldspar phenocrysts of various sizes up to 1 mm. and occasional quartz "eyes". Microscopic examination reveals abundant carbonatized plagioclase phenocrysts and a few quartz "eyes" set in a somewhat coarser and more mafic matrix than the rock described above and consisting of plagioclase, white mica, chlorite and magnetite. If this rock is indeed a lava it would probably have the composition of a dacite. A somewhat similar but more chloritized porphyry crops out nearby in lot 50.

Associated Pyroclastic and Sedimentary Rocks

Well-layered clearly tuffaceous sedimentary rocks were not observed in the rhyolites, but some field observations and petrographic investigations indicate that poorly layered tuffs may be present possibly in abundance in some sections. A dark buff weathering, irregular greyish green, weakly schistose breccia was taken for chemical analysis(No.1,Table 2), as an example of a rhyodacite flow breccia, but microscopic examination revealed a peculiarly inhomogeneous texture and what appeared to be fine primary layering suggestive of a pyroclastic origin. The rock is here classified as a tuff. It consists essentially of quartz and white mica, with some plagioclase, fine magnetite and chlorite grains, and some carbonate. The chemical analysis reveals its rhyolitic composition. It is noteworthy, chemically, that whereas the other two rhyolitic rocks analysed show high soda to potash ratio, the reverse is true for this rock.

Thin (up to 6 inches) layers of black cherty iron-formation occur as interbeds in rhyolite breccia near the main asbestos zone in range I and in a large rhyolite breccia outcrop in the northern half of the same range. The rock is very fine grained, rather featureless, and highly magnetic.

Red chert fragments up to a few inches long are seen in rhyolitic breccias in widely scattered localities. These fragments probably represent thin chert beds disrupted by advancing lavas or volcano-clastic flows.

## Basaltic Volcanic Rocks

### General Distribution

The basaltic volcanic rocks occur in two sections, a northern one and a southern one, which seem to differ essentially only in their degrees of metamorphism and deformation. Fresh-appearing in places, almost glassy lavas compose much of the southern section; they have undergone regional metamorphism of the greenschist facies. Penetrative structures arising through deformation, such as cleavages, schistosities, or lineations, are generally rare. In the northern section, on the other hand,

penetrative structures are commonplace, and include sets belonging to two phases of deformation. The lavas of the north section have been metamorphosed to the epidote-amphibolite facies in a broad zone spatially related to the La Reine granite pluton.

In other respects such as chemical compositions and lithological varieties the two sections appear to be similar and closely related.

The southern section of mafic to ultramafic lavas occupies a southwestern triangular portion of the township with a northeasterly boundary extending from about lot 50 on the Hébécourt-Roquemaure township line to the western end of the range V line.

The northern section is much more irregularly distributed in the northern half of the township forming the bedrock of much of Nepawa island, and Boundary point, numerous small islands, and the northeastern corner of the township.

Associations and Relationships

The mafic to ultramafic lavas have an intimate association with true ultramafic - ultrabasic intrusive bodies of serpentinized dunites and peridotites in range I of the township, and also with a variety of gabbroic and dioritic dikes and sills. Some of the dioritic and/or gabbroic intrusive bodies are regarded as penecontemporaneous to the effusive products of volcanism and form part and parcel of the overall volcanic events which produced the volcanic pile of submarine flood basalts. Other dioritic and gabbroic rocks, however, are undoubtedly much later than the volcanism and must properly be separated from it in the outline of the geological history. Some definitely late dioritic and gabbroic dike rocks were also intruded after major folding and faulting. The relationship of the basaltic lavas to the underlying rhyolitic lavas is not clear from map evidence and outcrop inspection. There is some indication that the main contact zone between the rhyolites and the basalts has a trend some 10 degrees off the normal trend of the overlying basaltic lavas. This suggests that the main contact zone represents a pre-basalt topographic slope and that the rhyolites formed a low domical structure which was surrounded by, and finally buried beneath, a flood of basalts. In the process, intermediate rock types of andesitic to dacitic composition were formed through the incorporation of rhyolitic debris in the basaltic lava outpourings; indeed, in the southeastern quarter of the township, distinctive interlayering between rhyolitic, andesitic and basaltic rocks exists, suggestive of such events. The intertonguing patterns seen in this southeastern quarter probably, if more outcrop were available, would also be seen to the northwest along the main contact zone.

Primary Structures of the Basaltic Lavas

In contrast to the rhyolitic lavas, the original or primary structures of the basalts and picrite or olivine-rich basalts are few in number and on the whole rather monotonously uniform. These lavas are either well pillowed with scant associated breccia, or are massive and almost completely devoid of structure, except for very narrow flow contact zones a few inches in thickness. Only in a few intermediate lavas of andesitic to dacitic composition, found along the general rhyolitic-basaltic contact zone, are good volcanic breccias developed in the mafic lava sequence.

Pillow Structure. - The pillows exposed in Roquemaure township are very thin-skinned (1 to 2 cm.), with a characterictic lack of development of any significant quantity of interpillow breccia, a common feature of pillowed basalts of normal composition in northwestern Quebec. The thinness of the enveloping skin is similar to that developed in buff-weathering, light green "dacite", seen not infrequently in Dufresnoy township and elsewhere in the Noranda area, in which the pillow forms are also very tight fitting with little or no interpillow breccia.

The pillows in Roquemaure township display a remarkable degree of plasticity; the individual pillows have nestled together and settled upon adjoining and underlying pillows to form close-packed pillowed masses. Another line of evidence indicative of the plasticity of the pillows at the time of their emplacement is the not infrequent occurrences of pillows which have folded over on themselves, so that the pillow skin shows, in cross-section, a tight re-entrant often up to 10 inches or more long, penetrating the individual pillow mass. Short (1 to 2 inches) pinches of the pillow rims are also seen in many localities. It is surprising that evidence of rent or broken pillow rims accompanied by budding is not observed: the enclosing skin must not only have been highly flexible to permit such folds and pinches to form but also extremely tough and durable.

Occasional quartz-filled cavities, usually in parallel sets 1/2 to 1 inch apart, 2 to 5 inches long, and presumably parallel to the original horizontal plane of deposition, occur in the upper parts of many pillows. Otherwise, except where obviously deformed, the pillows are amazingly uniform in aspect. Variations are subtle and usually consist of changes in hue of fresh or weathered surfaces, which for the most part reflect changes in chemical composition.

Pillows as seen in outcrop cross-section are usually quite variable as to sizes and shapes in most exposures. In size they range from 1 inch long and 2 inches thick up to 20 feet or more in length and 5 to 10 feet thick. Indeed, as will be related in the next section, the larger pillows appear to pass simply into thin flows without interruption. In shape, most pillows are ovoid masses commonly two to three times longer than they are thick. Balloons, bun and mattress forms are also very common.

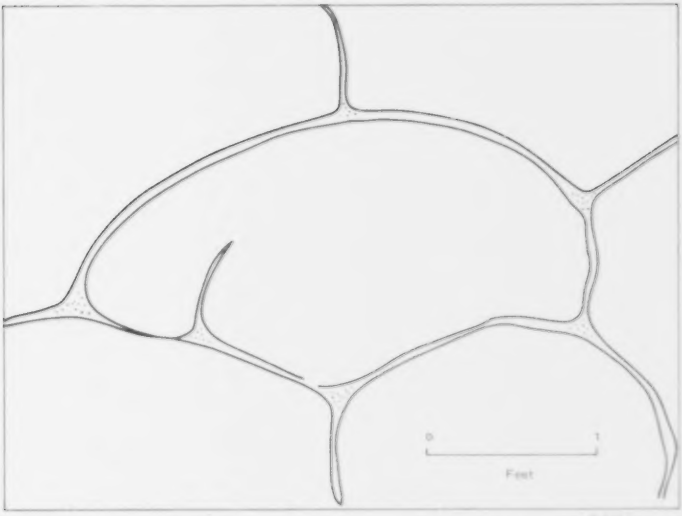


Fig. 1 A pronounced "foldover" in a large pillow in basalt; small island, lot 8, range IV.

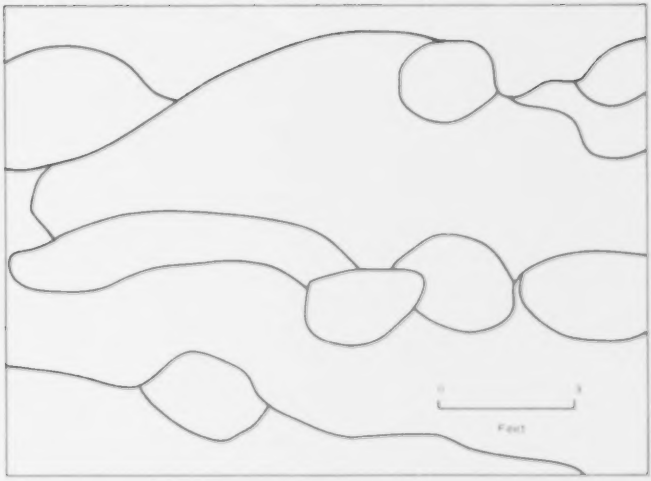


Fig. 2 An unusual assemblage of variously sized and shaped thin-skinned pillows in basalt; range I. (Sketched from field observations and a photograph).

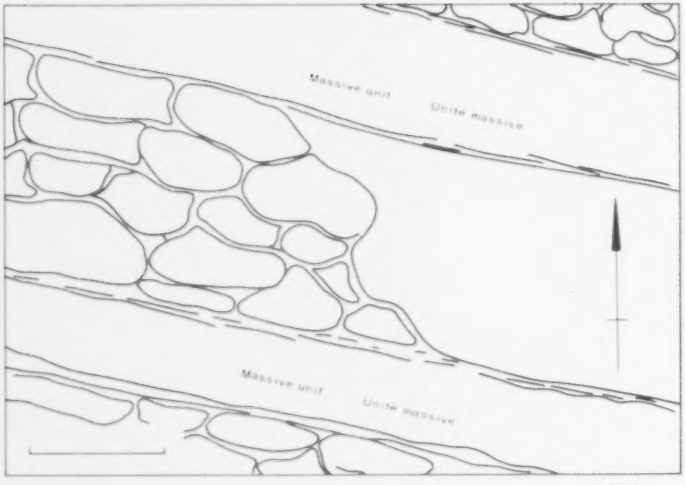


Fig. 3 Slightly overturned southward facing massive and pillowed flow units in picritic basalt showing one pillowed layer abruptly changing to a massive state along strike. Sketched from a large exposure in lot 19, range I. Flow unit contact are narrow and show a little more or less indistinct brecciation.

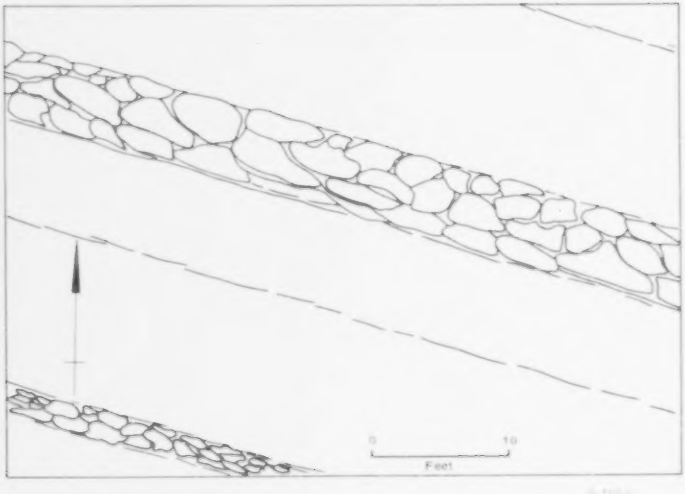


Fig. 4 Six-foot thick layer of pillows apparently forming the base of a massive flow unit. Other flow units in basalt are separated by thin (1" - 3") flow contacts.

On the average, most pillows are about 1 to 3 feet long. Determinations of tops, trends, and dips are readily made within about plus or minus 5 degrees of azimuth or inclination.

Relationships between Pillowed and Massive Lava Flows. Thin pillowed layers are found clearly interlayered with numerous thin (± 15 feet thick) massive lava flows, some passing laterally into massive lava. The change from pillowed to massive, or vice versa, forms has been observed in a number of instances, both vertically and horizontally within the basaltic lava accumulations. The relationships would suggest that pillows are merely small individual flows with each pillow rim in itself a flow contact.

Flow contacts in the usual sense of the word are rarely seen in the basalts, and when they are they usually consist of inconspicuous, thin (1 inch to 4 inches) layers of breccia of the same composition as the adjoining lava layers.

Broken Pillow Breccia. A remarkably clean exposure of an unusual volcanic breccia occurs at the north end of lot 19, range II, close to the range II-III road. A similar breccia, less well exposed, crops out on a small island on the northern side of the broadest section of the Antoine river where it enters Boundary bay.

The breccia consists of fragments from 1 inch to about 1 foot in size and of irregular angular shapes but closely fitting together with little fine interstitial material. The fragments are clearly pieces of pillows which have in some way been shattered, for many pieces have at least one edge which is clearly part of what was once a pillow rim. The breccia in the first locality occurs as two zones, separated by 5 or 6 feet of normal pillow lava with which the breccia appears to be interlayered. One breccia does not appear to be tectonic in origin but rather to be penecontemporaneous with the formation of the enclosing pillows (Carlisle 1963).

Incorporation Breccia. In several exposures on either side of the range I-II road, from lot 3 to lot 5, breccias made up of white-weathering rhyolitic fragments range from 1 inch to as much as 10 feet in length, but most are about 6 inches long. The disparate composition and the large size of some of the fragments suggests the engulfment of a rubbly mass of rhyolitic lava fragments by a very fluid andesitic to basaltic lava flow.

Lithological Varieties

In the field the obvious mafic extrusive rocks are reddish brown through brown and fawn on weathered surface, and grey to green on fresh surface. They are very fine grained and overall look like the typical dacites, andesites, and basalts of the Noranda district or of other areas in northwestern Quebec. They are characterized by the very thin skinned

nature of the pillows and the overall paucity of interstitial breccia between pillows and of associated pillow breccias.

Mineralogical and chemical examinations, however, reveal that the pillow lavas are for the most part much more mafic in mineral make-up and more basic in chemical composition than the lavas to the south, and that they have stronger affinities with the mafic and ultramafic volcanic rocks of the Hawaiian Islands than do the andesite-basaltic suites of most Archean belts. Anhauesser et al. (1968) have pointed out that both in African and Australian Shield areas the oldest volcanic rocks in the stratigraphic succession are mafic to ultramafic; they could find no evidence of such an early mafic to ultramafic succession in the Canadian Shield. Mineralogical and chemical results of the present study reveal,however, that such a mafic-ultramafic suite of lava flows does occur in the Canadian Shield, and may indeed be near the stratigraphic base of the local Archean succession.

Five specimens were selected for chemical analysis and concurrent thin-section study. Three of these specimens are either so altered by relatively mild regional metamorphism and slight deformation or stronger contact metamorphism as to be indeterminate as to original mineralogy, but two are so clearly fresh, even almost undevitrified, lavas, that little argument can be sustained about their ultramafic mineralogy. The two clear-cut cases of ultramafic lavas consist of fine-grained, porphyritic aggregates of abundant serpentine pseudomorphs after olivine, set in a very fine grained matrix of plagioclase crystallites and ill-developed scales of amphiboles. These specimens contain 14.59 and 16.84% MgO respectively and are picritic or olivine-rich basalts.

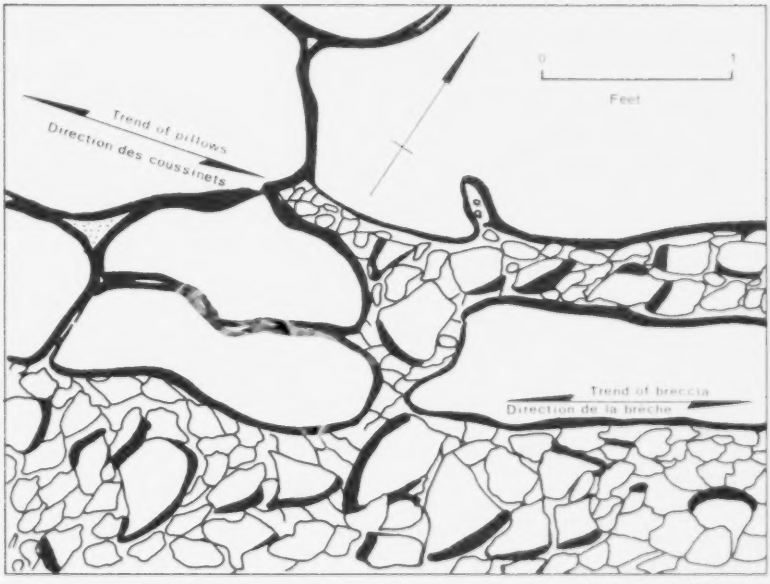


Fig. 5 Broken pillow breccia zones in pillowed basalt; drawn from photographs of an outcrop at the north end of lot 19, range II.

The other three specimens analyzed (Table 4) have varying amounts of MgO; nothing, however, can be determined directly of their original mineralogy. Two have chemical compositions of tholeiitic basalts and the fine-grained rather indeterminate mineralogical composition of either the greenschist facies or that of the amphibolite facies. The third is also an amphibolite facies rock composed almost entirely of actinolite-tremolite with disseminated sphene, but it contains 18.94% MgO and is clearly ultramafic.

The two "fresh" specimens and the one MgO-rich amphibolitic example make it clear that ultramafic or picritic basalts are present in some quantity over a large area of the township underlain by the mafic volcanic rocks. The thin-skinned pillow rims and the lack of pillow breccias probably reflect the mafic to ultramafic character of these basaltic lavas.

Basalts and Picritic Basalts. The freshest specimens of ultramafic, pillowed, picritic basalts are samples taken near the centre of lots 20 to 21, range I, and near the northern end of lot 19, range I (Nos. 5 and 6, Table 4). Both specimens are essentially similar macroscopically, microscopically, and chemically. They are reddish fawn to brown weathering, dark greyish green to greenish black, very fine grained massive pillowed rocks, with scattered fine tiny black masses and laths set in a somewhat lighter coloured groundmass. They are extremely tough and hard to break in outcrop. Under the microscope they are clearly seen to be very fine grained and porphyritic; they consist of serpentine pseudomorphs after equant, lath-shaped, and doubly terminated olivine phenocrysts (Wylie, p. 73) set in an altered, apparently barely devitrified, groundmass of plagioclase crystallites and serpentinized clinopyroxene and amphibole needles. The original texture of the rock is remarkably well preserved (Plate 2).

A basalt of more normal chemical composition although still with strong Havaiian affinities (No. 7, Table 4) was collected from a very clean, weathered shoreline exposure on the westernmost point of the peninsula in Boundary bay located in lot 6, range IV. The rock in this exposure is well pillowed, with narrow pillow margins, and has deep cream to brown weathered surface. It is a very fine grained, grey, porphyritic aggregate with tiny faults and fine quartz stringers trending in several directions and intruded by a "late" feldspar porphyry dike. Examination in thin-section reveals that it has a very finely developed, but marked preferred orientation of mineral grains which is not evident in the exposure. The rock is altered and consists of quartz, white mica, carbonate, magnetite, some chlorite, sphene largely altered to leucoxene, and epidote in a fine-grained melange in which it is difficult to separate the various minerals and identify their amounts with any degree of precision.

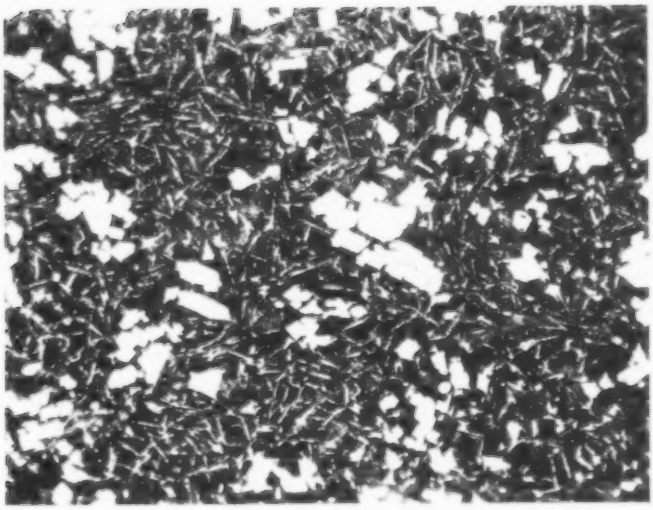

PLATE 2 Photomicrograph of porphyritic picrite basalt showing serpentine pseudomorphs after olivine phenocrysts set in a groundmass of tiny plagioclase crystallites and rather amorphous amphibolitic-pyroxenitic material.

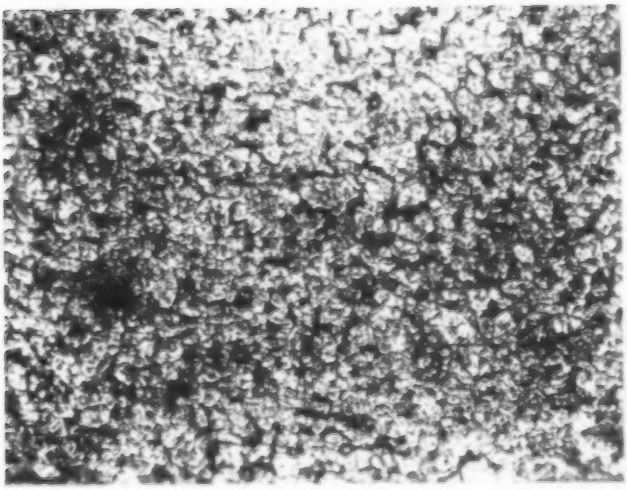

PLATE 3. Photomicrograph of serpentinized dunite. (sample No. 18)

Two other specimens (Nos. 8 and 4, Table 4) clearly, from an inspection of their chemical composition, form part of the basalt-picrite basalt suite of pillowed mafic to ultramafic lavas. They have, however, undergone considerably more metamorphism than the three samples described above and will be described mineralogically in the section dealing with metamorphism.

Without considerably more field work it is impossible to determine the extent of the very MgO-rich lavas in the township. Six additional grab samples from various localities show low MgO values indicating that the picritic basalts are probably limited to definite horizons within the volcanic pile. Table 6 contains the results of this additional sampling.

The term ultramafic and ultrabasic with regard to the Roquemaure lavas can be strictly justified for only one analysis where the silica content is below 45%; in the case of the other analyses of basalts, the percentage compositions of $SiO_2$ are over 45%, although only by a few percentage points. The term ultramafic, of course, is rather more subjective in its application and it is perhaps questionable where to draw the line with respect to the Roquemaure lavas. They most certainly are very mafic in many exposures and bordering on the ultramafic. It has been decided, however, to use the designation mafic to ultramafic with respect to the basaltic lavas in the discussions that follow. Due to their unusual mineralogical and chemical composition these volcanic rocks may be used, firstly, as possible stratigraphic markers in the delineation of the regional geology, and, secondly, in the possible delineation of a nickel-asbestos metallogenic province.

TABLE 4

Semi-quantitative Analyses of Mafic to Ultramafic Lavas from Roquemaure Twp.

| | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|
| $SiO_2$ | 45.39% | 41.51% | 47.61% | 48.48% | 47.61% |
| $TiO_2$ | 0.72 | 0.50 | 0.68 | 0.67 | 1.24 |
| $Al_2O_3$ | 7.53 | 10.70 | 8.41 | 14.76 | 13.80 |
| CaO | 9.12 | 9.21 | 10.28 | 11.57 | 11.25 |
| MgO | 18.94 | 16.84 | 14.59 | 7.46 | 6.13 |
| FeO* | 11.97 | 11.63 | 12.86 | 11.91 | 14.36 |
| $Na_2O$ | 0.45 | 0.79 | 1.48 | 1.88 | 2.10 |
| $K_2O$ | 0.11 | 0.03 | 0.07 | 0.04 | 0.44 |
| V | 0.017 | 0.015 | 0.016 | 0.016 | 0.030 |
| Cr | 0.022 | 0.27 | 0.23 | 0.057 | 0.006 |
| Fe (total) | 9.28 | 9.02 | 9.97 | 9.23 | 11.13 |
| Ni | 880 ppm | 790 ppm | 670 ppm | 151 ppm | 97 ppm |
| Cu | 40 " | 189 | 153 " | 155 " | 135 " |
| Zn | 87 " | 74 " | 83 " | 85 " | 108 " |
| Pb | 17 " | 18 " | 13 " | 22 " | 18 " |

* original determination was for total iron. For purposes of calculation and comparison total iron has been entirely converted to FeO.

4 Amphibolitized pillowed picrite basalt; sample taken from single pillow centre; shoreline exposure, north shore of Nepawa bay, lot 21, range IX, Nepawa island.

5 Pillowed picrite basalt;whole rock sample taken from small road cut on west side of lot 20-21 road in the northern part of range I.

6 Pillowed picrite basalt; sample from single pillow from a large ridge exposure at the north end of lot 19, range I.

7 Pillowed basalt; sample taken from centre of single pillow from clear shoreline exposure, lot 6, range IV.

8 Finely amphibolitized basalt with stretched pillows from road cut, lot 15, range VIII, Nepawa island.
All analyses by the Laboratories Branch, O.D.N.R.

TABLE 5

Composition of some Hawaiin and other Archean Lavas

| | D | E | F | G |
|---|---|---|---|---|
| $SiO_2$ | 50.45% | 42.30% | 43.89% | 51.8% |
| $TiO_2$ | 2.33 | 2.41 | 0.94 | 1.13 |
| $Al_2O_3$ | 14.94 | 10.52 | 14.64 | 15.2 |
| $Fe_2O_3$ | 3.38 | 4.22 | 3.03 | 1.5 |
| FeO | 7.55 | 9.70 | 8.77 | 7.8 |
| MnO | 0.08 | 0.06 | 0.21 | 0.18 |
| MgO | 7.67 | 14.90 | 7.36 | 5.3 |
| CaO | 9.17 | 12.08 | 10.46 | 8.6 |
| $Na_2O$ | 2.84 | 1.56 | 2.02 | 2.96 |
| $K_2O$ | 0.35 | 0.42 | 0.23 | 0.32 |
| $H_2O$ | 0.23 | 0.45 | - | - |
| $H_2O+$ | 0.73 | 0.87 | - | - |
| $P_2O_5$ | 0.27 | 0.33 | 0.19 | 0.14 |
| $Cr_2O_3$ | 0.05 | 0.11 | - | - |
| | 100.04 | 99.93 | 99.82 | |

D Average of 10 basalts, Koolau Series, Oahu. Turner and Verhoogen, 1960, p. 220.

E Picrite Basalt, Haleakala, Hawaii. Turner and Verhoogen, 1960, p. 220.

F Average composition of 53 Archean basalts; Wilson et al., 1965, p. 167.

G Mean of 130 analysis from the Noranda volcanic belt; Baragar, 1968, p. 779.

TABLE 6

Nickel and MgO in Some Other Pillowed Basaltic Rocks in Roquemaure Township

| No. | ppm Ni | %MgO |
|---|---|---|
| 9 | 130 | 5.08 |
| 10 | 120 | 6.34 |
| 11 | 140 | 6.22 |
| 12 | 50 | 3.36 |
| 13 | 150 | 5.44 |
| 14 | 30 | 5.64 |

9 - Pillowed basalt, north end lot 19, range II
10- Pillowed basalt, north end, lot 9, range II
11- Amphibolitized pillowed basalt, lot 37, range IX
12- Pillow andesite, lot 4, range II
13- Pillowed basalt, lot 14, range III
14- Pillowed basalt, roadcut south end lot 21, range I.

Andesites. Lava flows and breccias of andesitic composition have only been identified in range I to III in the southwestern third of the southeastern quarter of the township, where they occur at the base of the mafic volcanic succession, in part interlayered with underlying rhyolitic lavas, and in part associated with the range I asbestos zone and its serpentinized dunites and peridotites.

In many cases the andesites are difficult to distinguish from the basalts in the field, because under alteration by regional metamorphism they are both made of very fine grained aggregates of the same general suite of secondary minerals (quartz, white mica, chlorite, serpentine, magnetite, carbonate). The proportions do not vary enough to be distinctly reflected in weathered or fresh surfaces of hand specimens. In the main the andesitic lavas occur largely as either massive flows or breccias, and do not appear to form pillowed units.

One specimen (No. 16, Table 7), taken on lot 38, range II, as a typical "dacite", is a fawn-weathering, greenish grey, very fine grained aggregate. Examination in thin-section reveals that it is finely porphyritic, and consists of altered phenocrysts of plagioclase and augite in a groundmass of relatively large carbonate grains, chlorite, etc., but seemingly lacking in quartz.

A second specimen from lot 48, range I (No. 15, Table 7), is a more distinctive rock: a buff to greyish white weathering, pale grey, very fine grained, porphyritic aggregate with carbonate amygdules. In thin section, this rock has a distinct trachytic texture with scattered completely altered phenocrysts of pyroxene in a groundmass of plagioclase, carbonate, etc.

Tuffs. Tuffaceous rocks were rarely identified in the field and appear to make up a very small part of the succession of basic lavas.

A layer of crystal tuff of undefined dimensions occurs in the middle of lot 46, range II, in association with andesitic material containing numerous large rhyolitic fragments, i.e. of the incorporation breccia type described in a previous section. The rock consists of scattered equant to lath-shaped plagioclase crystals and generally smaller and less numerous augite crystals set in a scarcely devitrified, crudely layered, very fine grained groundmass containing crystallites of feldspar. The rock is slightly altered and contains some secondary quartz.

TABLE 7

ANDESITES

| | 15 | 16 | H | I |
|---|---|---|---|---|
| $SiO_2$ | 56.45% | 54.54% | 53.1 % | 51.83% |
| $TiO_2$ | 1.10 | 0.82 | 0.92 | 1.11 |
| $Al_2O_3$ | 15.27 | 15.04 | 17.90 | 14.53 |
| CaO | 3.98 | 4.49 | 7.65 | 8.42 |
| MgO | 4.25 | 5.97 | 4.26 | 6.22 |
| $Fe_2O_3$ | - | - | 0.84 | 2.90 |
| FeO | 8.61* | 7.34* | 5.78 | 8.46 |
| $Na_2O$ | 2.93 | 4.30 | 3.69 | 3.40 |
| $K_2O$ | 1.49 | 0.58 | 0.60 | 0.29 |
| V | 0.015 | 0.014 | | |
| Cr | 0.006 | 0.013 | | |
| Fe (total) | 6.75 | 5.69 | | |
| Ni | 116 ppm | 82 ppm | | |
| Cu | 88 " | 53 " | | |
| Zn | 77 " | 126 " | | |
| Pb | 12 " | 38 " | | |

* original determination was for total iron. For purposes of calculation and comparison, total iron has been entirely converted to FeO.

15 Altered andesite lava; lot 48, range I, asbestos zone; (Analysis by the Laboratory Branch, Q.D.N.R.)

16 Highly altered andesite lava; lot 38, range II (Analysis by the Laboratory Branch, Q.D.N.R.)

H Duparquet No. 8 specimen; Baragar, 1968

I Average composition of 20 Archean andesites; Wilson et al., 1965, p. 167.

A fairly certain occurrence of tuff in the northern mafic volcanic belt occurs on the western shore of a small island in lot 25, range VIII, south of Nepawa island. Here a 4-foot layer of finely bedded felsic material is crumpled and shredded by schistosity in a small local fold. In hand specimen the rock is fawn-weathering, greenish grey in colour, very fine in grain, hard and well-foliated, with a fine streaky appearance. Microscopic examination reveals a typical greenschist assemblage of quartz, albite, epidote, chlorite and magnetite as a strongly schistose aggregate with ill-defined layering, probably represents transposed bedding, and large elongated "eyes" of quartz and occasional large feldspar grains.

Another good exposure of tuffs occurs on the north shore of Lake Abitibi on the northwestern side of La Sarre bay in lot 52,range X. The rock is composed of very fine grained material, greyish white to light fawn on the weathered surface, and grey-green to grey on the fresh surface, associated with dark green weathering, dark green layers from 1 inch to 3 feet thick. Examination under the microscope reveals a highly altered schistose aggregate of fine quartz, chloritized biotite, carbonate, and magnetite. The rock appears to be a sheared felsic tuff interbedded with the surrounding pillowed lavas. Several similar exposures are present in the general vicinity.

Well-layered, thin (1 inch to 3 inches) alterations of green and buff material can be mistaken for tuffs because of the appearance of seemingly good bedding, but this rock type can be clearly demonstrated, in many exposures in the northern half of the township, to be the result of intense stretching and metamorphism of pillowed basalts: the dark layers representing the pillow centres and the lighter layers the remnants of the pillow margins.

## INTRUSIVE ROCKS

The intrusive rocks of Roquemaure township fall into four major categories according to their ages relative to the volcanic sequences, and to each other:

1 - salic and mafic intrusive bodies penecontemporaneous with the salic and mafic volcanic assemblages;
2 - post-volcanic and pre-granitic salic and mafic dikes and sills;
3 - granodioritic and granitic plutonic rocks probably of different absolute ages;
4 - post-granitic salic and mafic dikes.

In addition, some small lamprophyre dikes and late diabase dikes of two ages crop out in the map-area.

The range in chemical and mineralogical compositions is great: from ultrabasic to acidic, from ultramafic to highly salic, from dunite to rhyolite porphyry.

## Rhyolite Porphyry and Related Dikes

Rhyolite porphyry bodies and a plethora of quartz-feldspar and feldspar porphyry dikes and sills make up most of the exposures in the eastern outcrop area of rhyolitic rocks in ranges IV to VI of the township. These fine-grained salic (felsic) rocks occur as a confusing assemblage of small units in association with thin units of rhyolitic lavas and breccias and later fine-grained dioritic dikes; they show varying degrees of deformation. Age relationships among the various types are not at all clear, partly because of the poor quality of outcrop surfaces, but furthermore because of faulting and shearing along and across many of the observable contacts. This melange of lithological types has been shown on the map as a "rhyolite complex". The boundaries of this complex as shown on the map are more or less arbitrarily defined.

Within this complex it has been found impossible to separate out any of the various units except for a few prominent ones because of their narrowness in outcrop (usually from 1 foot to 10 or 20 feet), and lack of continuity, except in the case of the late dioritic dikes which are generally rectilinear in trend.

Most of the salic dikes are probably penecontemporaneous with the rhyolitic volcanism because,apart from a distinctive feldspar-quartz porphyry occasionally found as narrow dikes across the basaltic volcanic rocks, salic dikes are very rare in the latter, except within a hundred feet or so of major granitic or granodioritic bodies, in the northern half of the township, to which such dikes are obviously related. It is conceived that the "rhyolite complex" largely represents part of a centre of rhyolitic volcanism where one would expect to find numerous dikes, sills, and pipes of rhyolitic composition cutting into clearly extrusive rhyolitic lavas.

One of the commonest and most distinctive types, and certainly one of the earliest, because of its deformation along two directions of cleavage, is a rhyolitic feldspar-quartz porphyry which is found throughout the area of the "rhyolite complex", and also to the west in range V in the sections of larger bands of clearly rhyolitic lava.

TABLE 8

Intrusive Rhyolite Porphyry

| | 17 |
|---|---|
| $SiO_2$ | 73.62% |
| $TiO_2$ | 0.12 |
| $Al_2O_3$ | 10.32 |
| CaO | 2.80 |
| MgO | 0.43 |
| FeO* | 3.65 |
| $Na_2O$ | 4.20 |
| $K_2O$ | 0.91 |
| V | 0.005 |
| Cr | 0.009 |
| Fe (total) | 2.83 |
| Ni | 10 ppm |
| Cu | 71 " |
| Zn | 55 " |
| Pb | 8 |

17 Rhyolite porphyry or feldspar-quartz porphyry from north end of large outcrop 100 feet south of the range road in the southern end of lot 46, rang, V, Roquemaure Township.

* original determination was for total iron. For purposes of calculation and comparison, total iron has been entirely converted to FeO.

The specimen of rhyolite porphyry selected for analysis (No. 17, Table 8), typical of this quite consistent rock type, is a greyish white to cream weathering, grey, very fine grained, porphyritic aggregate with tiny feldspar phenocrysts and scattered quartz eyes, and numerous tiny carbonate grains. It was collected on lot 46, range V. The rock is intersected by thin zones of "wispy" cleavage 3 to 4 inches apart. Under the microscope the rock is seen to be composed of scattered, lightly altered, oligoclase phenocrysts and angular to rounded quartz phenocrysts, somewhat fewer in number, all set in a very fine grained matrix of plagioclase, quartz, white mica, chlorite, and magnetite accompanied by accessory sphene and apatite.

A distinctive green, quartz-feldspar porphyry occurs on the south shore of Lake Abitibi in lot 45, range VI, as a fawn to light brown weathering, massive, very fine grained rock with angular white feldspar phenocrysts, 1 to 3 mm. in length, and numerous dark grey rounded quartz "eyes", with occasional grains of carbonate. What appears to be the schistose equivalent of this dike-rock type crops out in lot 39, range VI, on the shore of Lake Abitibi. The latter rock, apart from being deformed and speckled with reddish brown grains of carbonate and pyrite comprising up to 15% of the rock, contains very occasional chlorite-magnetite masses pseudomorphous after pyroxene or some other mafic mineral.

Dunite and Peridotite and Related Serpentinite

The ultramafic intrusive rocks, peridotite and dunite, and their altered derivatives, composed largely of serpentine, represent, apart from the small intrusions associated with the earlier volcanism, the oldest intrusive rocks in the township. Because of their close chemical affinities they are most probably genetically related to the enclosing pillowed basalts and pillowed picritic basalts. The ultramafic masses occur as a number of branching anastomosing sills in the southern half of range I, from lot 42 to lot 55, where the ultramafic zone passes into range X of Hébécourt township. Good exposures of these rocks underlain by pillowed basaltic lavas are, however, limited to lots 44 to 48 on the rugged northern flank of a prominent ridge. The terrain here has a rugged microrelief and supports a lush second growth of small trees and shrubs making mapping of the many small outcrops present difficult. Proper detailed mapping would require cutting a grid of lines 100 feet apart, and clearing some of the outcrops of shrubbery.

The ultramafic intrusive bodies appear to be generally conformable to the structure of the enclosing volcanic rocks, and are therefore largely sill-like in form. They intrude typical pillowed basalts, picritic basalts, andesitic lavas, and diabase and diorite bodies related to these volcanic units, as well as some thin layers of agglomerate and one layer of black chert. The zone of ultramafic intrusions as a whole is bounded on its northern side by rhyolite breccias into which some smaller bodies of peridotite or dunite have been injected. The overall trend of the ultramafic zone is N.70°W. parallel to the overall trend of the enclosing volcanic rocks.

In outcrop, apart from generally soft, white-weathering surfaces, the ultramafic rocks vary considerably in appearance and grain size, and show considerable variability in degrees of brecciation, alteration, and veining by chrysotile and other serpentine minerals. On fresh surfaces the ultramafic rocks are dark green to black in colour.

One specimen from lot 48, range I, was examined in detail (No. 18, Table 9). It consists almost entirely of serpentine pseudomorphs after rounded olivine grains with some magnetite and oxidized pyrite. This rock represents a typical serpentinite developed through the strong alteration of a dunite. The exposures from which the specimen was taken is cut by widely spaced, thin, one 1/16 to 1/8 inch veinlets of chrysotile asbestos of seemingly good fibre quality.

A second specimen (No. 19, Table 9), from the same location, consists essentially of serpentine pseudomorphs after olivine, some of the grains which appear to be zoned, with remnants of clinopyroxene. The rock can be classified as a serpentinized dunite.

TABLE 9

Semi-Quantitative Analyses of Ultramafic Intrusions

| | 18 | 19 | J | K |
|---|---|---|---|---|
| $SiO_2$ | 37.80% | 37.72% | 41.77% | 41.61% |
| $TiO_2$ | 0.08 | 0.13 | 0.13 | 0.20 |
| $Al_2O_3$ | 2.75 | 3.94 | 2.30 | 5.61 |
| CaO | 0.20 | 3.54 | 0.95 | 6.67 |
| MgO | 36.94 | 32.46 | 37.88 | 26.50 |
| FeO | 6.36* | 9.31* | 5.59* | 3.52 |
| $Fe_2O_3$ | - | - | - | 8.23 |
| $Na_2O$ | 0.08 | 0.07 | - | 0.30 |
| $K_2O$ | 0.02 | 0.06 | 0.1 | 0.24 |
| V | 0.010 | - | - | 0.008 |
| Cr | 0.026 | - | - | 0.12 |
| Fe(total) | 4.93 | 7.22 | - | - |
| Ni | 2640 ppm | 2160 ppm | 0.22% oxide | 0.15% oxide |
| Cu | 26 " | 25 " | - | tr |
| Zn | 47 " | 46 " | - | 0.00 |
| Pb | 13 " | 12 " | - | tr |

* original determination was for total iron. For purposes of calculation and comparison, total iron has been entirely converted to FeO.

18 Serpentinite derived from a dunite; south end of lot 48, range I, in main asbestos zone. (Analysis by Laboratory Branch, Q.D.N.R.)

19 Serpentinized dunite; south end of lot 48, range I, in the main asbestos zone. (Analysis by Laboratory Branch, Q.D.N.R.)

J Mean from five analyses of metaperidotite from the Marbridge mine, LaMotte twp., Quebec (Clark, 1965, p. 797).

K "Hard Massive" Peridotite, Barnat mine, Malartic District, Quebec (Eakins, 1962, p. 126)

A third specimen from lot 46, range I, examined only microscopically consisted in hand specimen of a white-weathering, greenish black, medium-grained brecciated aggregate, which under the microscope is seen to be composed entirely of serpentine except for some magnetite. The rock is a typical serpentinite with no relicts of its original mineral constituents.

Chemically these rocks show strong kinship with the picritic or olivine basalts, and are remarkably similar to the metaperidotites of the Marbridge nickel mine in LaMotte township north of Malartic (Clark, 1965). They appear to be quite different chemically from the peridotite injected along the Cadillac-Malartic "Break" (Eakins, 1962).

The conclusion that these ultramafic intrusive rocks were penecontemporaneous with the enclosing basalts and derived by differentiation from the same magmatic sources appears reasonable.

"Red-chert" Gabbro

Sill-like masses of massive, fine- to medium-grained, gabbroic rocks characteristically containing fragments, blocks, and septa up to 20 feet long of red, red and white, and occasionally red, white and black chert are particularly prevalent in ranges II and III of the southwestern quarter of the township. The rock making up these masses is not easily distinguishable from other fine-grained gabbros and diorites, but is distinctive enough to be separated from them locally and to merit separate treatment. These gabbroic masses may be more or less penecontemporaneous with the enclosing basalts; in themselves they do not, however, exhibit any volcanic structures, nor do they appear to be massive lavas.

Typically these gabbroic rocks are dark green and weather buff to deep buff; they are easily broken, often with a somewhat slippery, soft feel in hand specimen.

Some bodies are slightly schistose and others are distinctly porphyritic. Because of the general fineness of grain and a lack of good exposures that would show contact relationships, all gabbroic and dioritic rocks have been lumped together on the map, although it is recognized that there are numerous varieties of different ages present.

The one specimen analyzed (No. 20, Table 10), of the "red chert" gabbro is light brown to reddish fawn on weathered surface and olive greenish grey to dark green on fresh surface. The rock is somewhat schistose and consists of a fine-grained aggregate, containing widely scattered, dark-rimmed, rosy red, rounded grains, 1/8 to 1/4 inch in diameter. Microscopic examination reveals a schistose, rather granulated aggregate of metamorphic minerals developed from the alteration of a fine gabbro or coarse basalt. Apart from a little highly altered pyroxene, and a few serpentine masses which may represent olivine pseudomorphs, the rock is largely made up of carbonate, chlorite, magnetite (+ 10%) and quartz. The pink specks seen in hand specimen are carbonate grains rimmed by chlorite and may also be pseudomorphs after olivine, although the possibility that they are amygdules cannot be ruled out.

A possibly more mafic member of this group occurs in lot 10, range III, in a small shoreline exposure where the Antoine river debouches into its broad estuary from its narrow sinuous swampy course. The rock exposed is fawn-weathering, green, fine grained and massive; it contains occasional fragments of red chert. Under the microscope it displays evidence of an original sub-ophitic texture, largely allotriomorphic granular. The rock is a melange of remnants of primary minerals and a host of secondary minerals: clinopyroxene, highly altered plagioclase, large chlorite flakes,

some masses of chlorite variety penninite, some serpentine possibly pseudomorphous after olivine, magnetite, and considerable quartz, carbonate and epidote.

Porphyritic varieties of similar affinities occur in several places, notably on the shores of Boundary bay, on several islands across the boundary in the province of Ontario opposite lot 1, range III, and in lot 15, range II. In the latter location the rock is green with a fawn to brown weathering, fine-grained, and composed of black stubby phenocrysts up to 2 mm. long set in an equigranular matrix containing minor disseminated pyrrhotite. In thin-section the rock is seen to be pronouncedly porphyritic with fresh clinopyroxene phenocrysts and large flakes of green chlorite occurring as porphyroblasts. Such large chlorite porphyroblasts form large "splashes" of green under the microscope, and appear to be one of the typical alteration features of these early gabbros. The groundmass has a diabasic texture and consists of a relatively fresh assemblage of clinopyroxene, andesine-labradorite plagioclase, and magnetite with chlorite, epidote and pyrrhotite. The rock may be classified as a chloritized porphyritic micro-gabbro or diabase.

TABLE 10

"Red Chert" Gabbro

| | 20 |
|---|---|
| $SiO_2$ | 44.12% |
| $TiO_2$ | 1.49 |
| $Al_2O_3$ | 12.34 |
| CaO | 9.64 |
| MgO | 4.06 |
| FeO* | 12.73 |
| $Na_2O$ | 2.70 |
| $K_2O$ | 0.06 |
| V | 0.033 |
| Cr | 0.007 |
| Fe (total) | 10.52 |
| Ni | 52 ppm |
| Cu | 94 " |
| Zn | 115 " |
| Pb | 15 " |

* original determination was for total iron. For purposes of calculation and comparison, total iron has been entirely converted to FeO.

20 Altered gabbro; northern end of lot 14, range II about 700 feet south of the range II-III road; analysis by the Laboratory Branch, Quebec Department of Natural Resources.

The chert xenoliths found in these gabbroic rocks are highly variable in size, ranging from tiny fragments up to septa in places 10 feet or more in length. They are made up of well-bedded and often highly contorted sedimentary material. Small fragments are usually red, whereas larger ones are multi-coloured. A typical example of a large xenolith is exposed in lot 14, range II close to the site of Sample 20, Table 10. About 15 feet of layered chert is well exposed as a septum about 1 foot wide. At one end it broadens out to 2.5 feet of contorted, bedded and brecciated material: the enclosing slightly schistose gabbro is quite uniform and free of smaller fragments. The chert mass consists of brilliant red fragments and layers of greyish white and black chert. Under the microscope the chert is seen to be made up of hematite-stained or clear cryptocristalline quartz with abundant tiny carbonate rhombs and scattered minute magnetite grains. Where the magnetite occurs within the hematite-stained chert it is surrounded by narrow rims of clear chert — the hematite has been drawn from the surrounding rock to form the magnetite grains.

The presence of chert in this early gabbro may be explained by presuming that a bed of cherty sediments in a pile of pillowed and massive lavas would provide a readymade plane of weakness for the intrusion of a sill, which in the process of its emplacement ripped up and engulfed the chert. Satterly (1948, p. 7) records photographically the magmatic "stoping" of an interflow chert bed, 30 inches thick, by a diabase sill in Michaud township, Ontario.

The "red chert" gabbros, as noted earlier, are not shown as separate units on the map but are incorporated in the general class of dioritic and gabbroic rocks. This was necessary because they could not be satisfactorily delineated in the field, largely because of a lack of exposures and the difficulty of distinguishing fine-grained rocks of other affinities from the "red chert" gabbros in moss and lichen-covered exposures.

## Roquemaure Gabbro or Quartz Diorite

A distinctive mafic intrusive rock of strong gabbroic affinities forms several prominent knolls and ridges with an east-west trend in an area extending over a length of several miles from a point about one mile east of Roquemaure in the south central section of the township. Its presence is well reflected by an anomaly on the aeromagnetic map*. Several prominent outcrops of the same rock occur for a distance of 1,000 to 2,000 feet west of the village of Roquemaure, and elsewhere to the north.

This gabbro weathers to smooth rounded surfaces, rich chocolate-brown to reddish brown in colour. It is generally medium grained but characteristically also contains local pegmatoid sections of considerably coarser grained material. It is very similar in many aspects, particularly in hand specimen, to the "older gabbro" or quartz diorite of the Noranda region to the south as described by Cook (1937) and later by Wilson (1939) and others.

* G.S.C. Map 446

As exposed east of the village of Roquemaure it is best named a gabbro because of its strong melanocratic character, but away from the area of Roquemaure in the outcrops along the range II-III road it tends to grade into more dioritic type rock, although typical gabbroic facies are to be seen to the west on the shores of Boundary bay and to the east along banks of the Duparquet river.

In and around the village of Roquemaure no well-defined contacts are exposed for the body as a whole; contact relationships are greatly complicated by sections containing scant to numerous xenoliths of rhyolitic and basaltic lavas from several inches to tens of feet in length and breadth. Essentially the mass has an east-west trend but as to dip or overall three-dimensional geometry little is known: it is probably a major sheet-like body stretching across the township from east to west with many related satellite bodies.

Another noteworthy feature of this gabbro in outcrop is its apparent massiveness upon first inspection. Closer examination reveals a complicated network of horizontally to vertically dipping, narrow, 1/16- to 1/4-inch quartz stringers, which intersect the rock, every few inches to every few feet, with azimuths in all directions. The rock is not as undeformed as first appearances would suggest, and it may well have been intruded into the volcanic assemblage before any folding took place. Certainly it is no less deformed than most of the enclosing volcanic rocks which have been turned on end without the development of any prominent penetrating structures, apart from the formation of numerous quartz stringers and small faults.

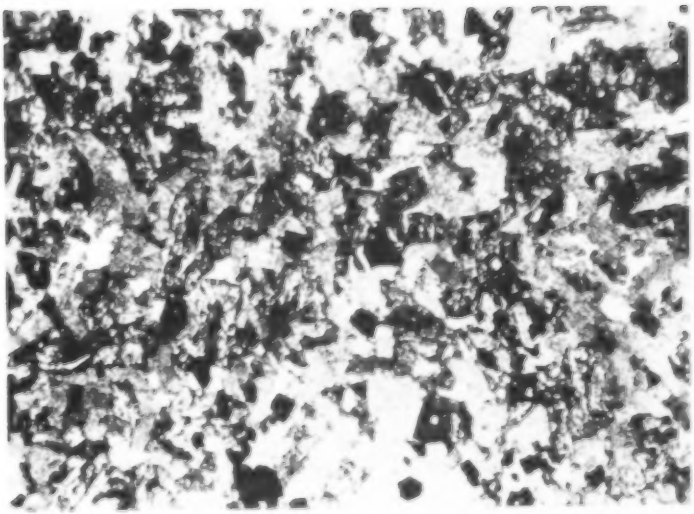

PLATE 4 Photomicrograph of medium-grained Roquemaure gabbro.

One sample of Roquemaure gabbro taken for chemical analysis (No. 21, Table 11) consists of a reddish brown weathering, dark green, medium-grained aggregate, which shows under the microscope a sub-ophitic, hypidiomorphic granular texture involving uralitized pyroxenes (40 to 45%), some fresh, but most heavily saussuritized plagioclase, originally andesine-labradorite (35 to 40%), quartz (10%) and magnetite in large grains (10%). Some micrographic intergrowths, epidote and chlorite are present.

A second specimen of "typical" Roquemaure gabbro from lot 48, range III, is somewhat more melanocratic in hand specimen and contains less quartz (7 to 8%) and feldspar grains (35%) which are all thoroughly altered, and more pyroxene and uralite (45%), and magnetite (12 to 15%).

This gabbro is cut by narrow felsic and mafic dikes and late diabase dikes in many places. The remarkable chemical feature of this rock is its very high iron content. It does not appear to be related to the mafic-ultramafic volcanic rocks.

## Gabbros and Diorites

Throughout the township except in the sections underlain by granodiorite or granite bodies, sills and other masses of brown-weathering, "salt and pepper" white and green, massive rock from fine to medium grain are common features. These rocks are also common throughout the surrounding region of northwestern Quebec; they are generally designated as diorites or meta-diorites, although in many instances they might be more correctly designated gabbros, metagabbros, or leucogabbros.

From its general aspect in outcrop and hand specimen the rock is uniform, a conclusion which is supported by microscopic examination and chemical analysis (Table 12), and it represents a major engulfment of the volcanic suites by intermediate to mafic material which in toto may be comparable in terms of volume to the more striking granitic invasions, at least within the greenstone belts proper, excluding their enveloping terrains of granitic gneisses and granites.

The geometry and orientation of many of the smaller bodies of diorite can be delineated with some precision in the field, but such is not the case for most of the larger bodies, because of a lack of exposures, and/or a lack of reliable contact information. The outline of the gabbro-diorite bodies on the accompanying map is, therefore, in many sections highly conjectural and open other interpretations.

It should also be noted that it proved impossible to separate the gabbro-diorite bodies from most of the metamorphosed basalts in the northern half of the township and the amphibolites developed from both major rock types. Such a differentiation would only be possible by very detailed mapping and the study of numerous thin sections.

TABLE 11

Roquemaure Quartz Gabbro

| | 21 | 22 | L |
|---|---|---|---|
| $SiO_2$ | 47.30% | 45.29% | 51.75% |
| $TiO_2$ | 2.40 | 2.62 | 1.15 |
| $Al_2O_3$ | 11.28 | 11.20 | 17.47 |
| CaO | 8.43 | 9.55 | 9.40 |
| MgO | 3.99 | 3.94 | 5.20 |
| FeO | 18.95* | 21.37* | 9.16 |
| $Fe_2O_3$ | - | - | 2.96 |
| $Na_2O$ | 3.06 | 1.86 | 1.37 |
| $K_2O$ | 0.19 | 0.26 | 0.43 |
| V | 0.031 | 0.045 | |
| Cr | 0.015 | 0.005 | |
| Fe (total) | 14.69 | 16.57 | |
| Ni | 22 ppm | 25 ppm | |
| Cu | 66 " | 112 " | |
| Zn | 120 " | 105 " | |
| Pb | 16 " | 13 " | |

* original determination was for total iron. For purposes of calculation and comparison, total iron has been entirely converted to FeO.

21 Gabbro from an exposure at the southern end of lot 48, range III. (Analysis by Laboratories Branch, O.D.N.R.)

22 Gabbro from the southern end of lot 52, range III. (Analysis by Laboratories Branch, O.D.N.R.)

L Pyroxenic gabbro: Dufresnoy Township (Wilson, 1941, p.29).

TABLE 12

Gabbros and Diorites

| | 23 | 24 | 25 | M |
|---|---|---|---|---|
| $SiO_2$ | 47.52% | 47.13% | 47.82% | 48.36% |
| $TiO_2$ | 1.44 | 1.23 | 1.44 | 1.32 |
| $Al_2O_3$ | 13.87 | 13.35 | 13.48 | 16.84 |
| CaO | 9.40 | 8.95 | 11.13 | 11.07 |
| MgO | 5.57 | 8.03 | 6.42 | 8.06 |
| $Fe_2O_3$ | - | - | - | 7.82 |
| FeO | 15.02* | 14.19* | 13.25* | 2.55 |
| $Na_2O$ | 2.66 | 1.78 | 2.21 | 2.26 |
| $K_2O$ | 0.05 | 0.07 | 0.14 | 0.56 |
| V | 0.031 | 0.030 | 0.026 | |
| Cr | 0.008 | 0.016 | 0.007 | |
| Fe (total) | 11.64 | 11.00 | 10.27 | |
| Ni | 64 ppm | 79 ppm | 82 ppm | |
| Cu | 105 " | 139 " | 120 " | |
| Zn | 115 " | 73 " | 95 " | |
| Pb | 32 " | 13 " | 18 " | |

* original determination was for total iron. For purposes of calculation and comparison, total iron has been entirely converted to FeO.

23 Diorite from an exposure 650 feet south of range II-III road in lot 19, range II.

24 Early diorite, lot 23, range IV

25 Amphibolitized diorite from shoreline exposure, south shore of Nepawa island, lot 30, range VIII.

M Plutonic gabbro, Barth, 1962, p. 59.

A typical "fresh" specimen of "diorite" from lot 26, range VI, is a brown-weathering, dark green and white, medium-grained equigranular aggregate, revealed in thin section to consist of cracked or fractured, heavily altered plagioclase, hornblende (about 50%) and some chlorite.

An obviously more basic facies of the gabbro-diorite suite was examined in thin-section from specimens taken on the east bank of the Duparquet River in Palmarolle township just outside the map-area. The rock is a brown-weathering, greenish black and white, medium-grained, hypidiomorphic granular aggregate of saussuritized plagioclase, uralite amphibole (20%) with minor chlorite, epidote and apatite.

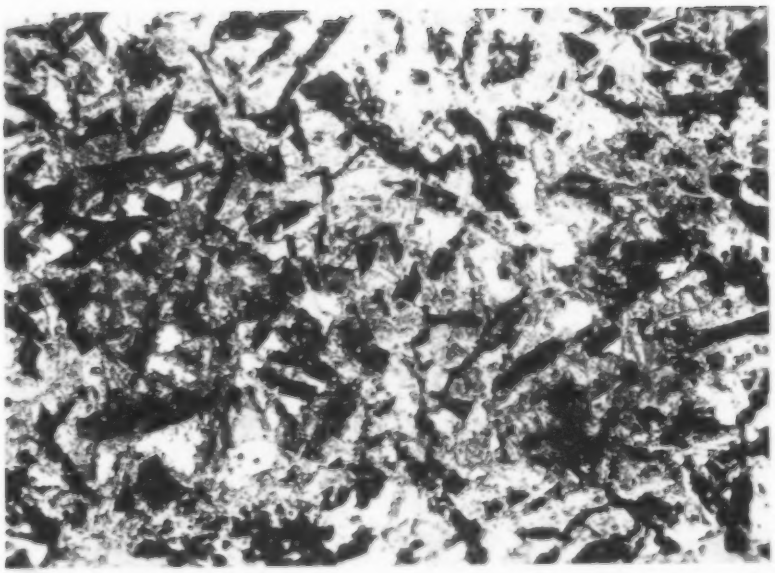

PLATE 5 Photomicrograph of fine to medium grained diabasic "early diorite".

Two specimens were chosen for chemical analysis. The first (23, Table 12), from the north end of lot 19, range II, is a greenish fawn to dark buff weathering, dark olive to dark greyish green, medium-grained, massive, more or less equigranular, aggregate with minor amounts of small disseminated irregular masses of pyrrhotite (1 to 3%). Under the microscope this rock is a slightly porphyritic, allotriomorphic granular aggregate of clinopyroxene with minor uralite, plagioclase, magnetite (5 to 6%), quartz (3 to 5%) with large flakes of chlorite. It contains less quartz than the Roquemaure gabbro, and has certain resemblances to the "red chert" gabbro.

The second specimen chosen for chemical analysis (No. 24) from lot 23, range IV, is a brown-weathering, dark green and white, fine- to medium-grained, massive aggregate containing minor pyrrhotite. Under the microscope it is seen to be a diabasic aggregate of highly saussuritized plagioclase (50%), uralite and chlorite (45%), quartz grains and crystals (3 to 5%) with minor micrographic intergrowths. The rock could be classified as either a quartz diabase (dolerite) or a metadiorite.

Late Dioritic to Gabbroic Dikes

Both within the "rhyolite complex" and the adjoining areas of rhyolitic and basaltic lavas, fine-grained dioritic to gabbroic dikes a few feet to a few tens of feet wide are common, have several orientations, and are undoubtedly of several different ages. Some have been broken up by faulting, whereas others seemingly are not so disrupted.

A good example of the complexity of relationships of some of these dikes, and for that matter applying also to many of the rhyolitic dikes, is to be seen in a small clean exposure near the bottom of a small hollow in pastureland in lot 22, range V, 1,200 feet north of the range IV-V road. Here several thin (ranging in width from several inches to about one foot) dioritic dikes intrude rhyolite breccia. The dikes have a general east-west trend, but along much of their exposed sections their contacts are irregular and blocky: the invading magma has forced apart the rhyolitic country rock along pre-existing fracture or joint planes, so that the dikes tend to zigzag across the lavas. In addition, every 10 to 15 feet the dikes are clearly offset by faults striking N.20°E. and dipping vertically.

In the "rhyolite complex" greenish grey narrow (1 foot to 10 feet wide) dikes are ubiquitous. They have a more or less constant north-northwesterly rectilinear trend and appear to be later than any of the quartz-feldspar or feldspar porphyries in the complex. Their relationships to other dioritic dikes, and the late feldspar porphyry is unknown.

The sample of this dioritic-type dike chosen for analysis on lot 46, range V (No. 26, Table 13), consisted of a greenish grey to buff weathering, greenish grey, fine-grained, equigranular aggregate of light

and dark minerals with the typical "sandy" aspect of these dikes on clear weathered surfaces. Examination under the microscope revealed a slightly porphyritic, fine-grained, highly altered, seriate to equigranular, allotriomorphic aggregate of altered plagioclase, carbonate, chlorite, and magnetite. The rock may be designated a strongly altered fine-grained porphyritic diorite.

Another intrusive rock of mafic character was sampled (Table 13, No. 27) in the asbestos zone on lot 38, range II. It is a light brown weathering, black spotted, greenish grey, fine-grained, equigranular, aggregate of fuzzy white feldspars and light and dark green dark minerals. Microscopic examination reveals a somewhat altered subophitic granular aggregate of plagioclase, biotite, augite, epidote, penninite masses and radial spherules of chlorite or hornblende in large scattered quartz grains.

A fine-grained, mafic dike cutting across medium-grained gabbro in lot 22, range IV, was chosen for analysis (No. 28, Table 13). This dike rock is a fawn-weathering, "salt and pepper", white and green, fine-grained aggregate in hand specimen. It is generally equigranular (0.5 mm.) with fuzzy mineral contacts and occasional slightly larger white feldspar grains. Examination in thin-section reveals a highly altered rock showing the remnants of an original diabasic texture and a little titaniferous augite. The rock is now mainly an aggregate of serpentine, chlorite, quartz (locally in surprisingly large amounts), hornblende, magnetite, leucoxene, and secondary sphene. The rock was originally a quartz diabase or micro-gabbro.

## Late Feldspar-Quartz Porphyry Dikes

Thin (from 1 foot to 10 feet in width), distinctive feldspar porphyry dikes with fairly regular north-northwesterly trends crop out in scattered localities. They cut across pillowed basalts and gabbros in the western halves of ranges II to IV. These dikes are typically white-weathering and contain an abundance of feldspar phenocrysts, some quartz eyes, and occasionally chloritic pseudomorphs after mafic phenocrysts. Their relationships to other dike rocks have not been observed.

The sample of these late feldspar porphyry dikes chosen for chemical analysis came from a thin dike intruding pillowed lavas in lot 6, range IV, on the shores of Boundary bay. This dike has a rather unique contact in that its trend is parallel to the trend of the enclosing, vertically dipping lavas: the contact locally follows around the pillows and into the re-entrants between pillows so that in effect the contact of the dike is a cast of the base of a series of pillows (Fig. 6). The rock is a white-weathering, light greenish grey, seriate to porphyritic, fine-grained aggregate of abundant white feldspar phenocrysts, 1 to 3 mm. in length, with scattered, irregular, greenish black chloritic masses, set in a fine-grained groundmass. The feldspar phenocrysts make up about 30 to 40% of the rock, the black masses about 8 to 10%.

TABLE 13

Late Intermediate to Basic Dike Rocks

| | 26 | 27 | 28 | N |
|---|---|---|---|---|
| $SiO_2$ | 56.18% | 54.79% | 47.12% | 51.86% |
| $TiO_2$ | 0.92 | 1.17 | 1.57 | 1.50 |
| $Al_2O_3$ | 13.43 | 15.70 | 13.31 | 16.40 |
| CaO | 5.05 | 4.79 | 9.31 | 8.40 |
| MgO | 3.43 | 4.68 | 6.02 | 6.12 |
| $Fe_2O_3$ | - | - | - | 2.73 |
| FeO | 7.95* | 9.13* | 16.06* | 6.97 |
| $Na_2O$ | 3.50 | 6.80 | 2.39 | 3.36 |
| $K_2O$ | 0.91 | 0.11 | 0.10 | 1.33 |
| V | 0.011 | 0.015 | 0.027 | |
| Cr | 0.009 | 0.005 | 0.029 | |
| Fe (total) | 6.16 | 7.08 | 12.45 | |
| Ni | 58 ppm | 88 ppm | 85 ppm | |
| Cu | 23 " | 115 " | 127 " | |
| Zn | 81 " | 80 " | 105 " | |
| Pb | 12 " | 18 " | 17 " | |

* original determination was for total iron. For purposes of calculation and comparison, total iron has been entirely converted to FeO.

26 Altered porphyritic diorite from a large outcrop 100 feet south of the road in lot 46, range V near the range IV-V line.

27 Somewhat altered diorite from the south end of lot 38, range II.

28 Quartz diabase or microgabbro dike from lot 22, range IV, cutting across "early" diorite

N Plutonic diorite (Barth, 1962, p. 58).

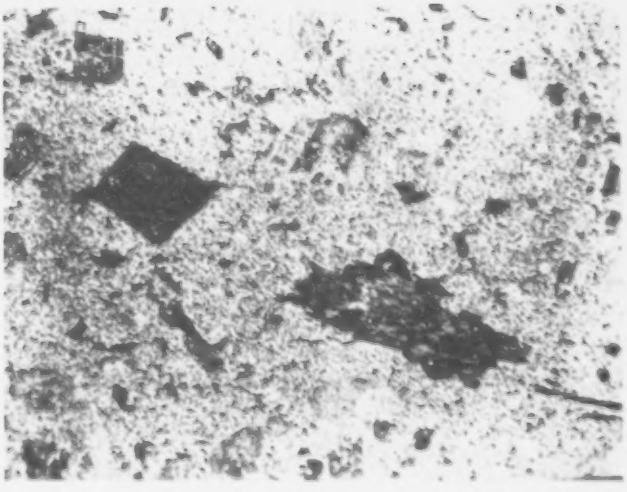

PLATE 6 Photomicrograph of feldspar-quartz porphyry showing magnetite-chlorite pseudomorphs after mafic phenocrysts (X 10)

TABLE 14

Feldspar-Quartz Porphyry

| | 29 |
|---|---|
| $SiO_2$ | 66.53% |
| $TiO_2$ | 0.32 |
| $Al_2O_3$ | 15.79 |
| CaO | 2.78 |
| MgO | 0.88 |
| FeO | 3.25 |
| $Na_2O$ | 5.90 |
| $K_2O$ | 1.23 |
| V | 0.005 |
| Cr | 0.005 |
| Fe (total) | 2.52 |
| Ni | 32 ppm |
| Cu | 45 " |
| Zn | 35 " |
| Pb | 13 " |

* original determination was for total iron. For purposes of calculation and comparison, total iron has been entirely converted to FeO.

29 Feldspar-quartz porphyry from the westernmost point of the small peninsula in Boundary bay in lot 6, range IV; (Analysis by the Laboratories Branch, Q.D.N.R.)

Fig. 6 Scalloped contact between a late feldspar porphyry sill and pillowed basalts; shoreline outcrop, lot 6, range IV. Note thin quartz-filled fractures.

Under the microscope the rock is seen to consist of altered plagioclase and large chlorite-magnetite masses, probably pseudomorphous after augite or some other mafic phenocryst, set in a groundmass of plagioclase, white mica, quartz, magnetite, chlorite and epidote.

Specimens of similar feldspar-quartz porphyry dikes from lot 12, range II, and from lot 13, range IX, on the north side of Nepawa island, examined under the microscope, show similar mineralogical compositions and textures, and prove this rock type to be wide spread in occurrence, although of relatively minor quantitative importance.

The relationships of these dikes to the main granitic masses in not known.

## La Reine Granite

The white-weathering, gneissic La Reine granite occupies the drainage basin of the Maine river, which is enclosed in Roquemaure township to the east and south by a semi-circular ridge of amphibolitized and deformed basaltic rocks and mafic intrusive bodies, and to the west more or less by the north shore of Nepawa island. The La Reine mass extends to the north into La Reine township and on the regional map (Dugas, Latulippe, Duquette, 1967) appears to be approximately almond-shaped in plan.

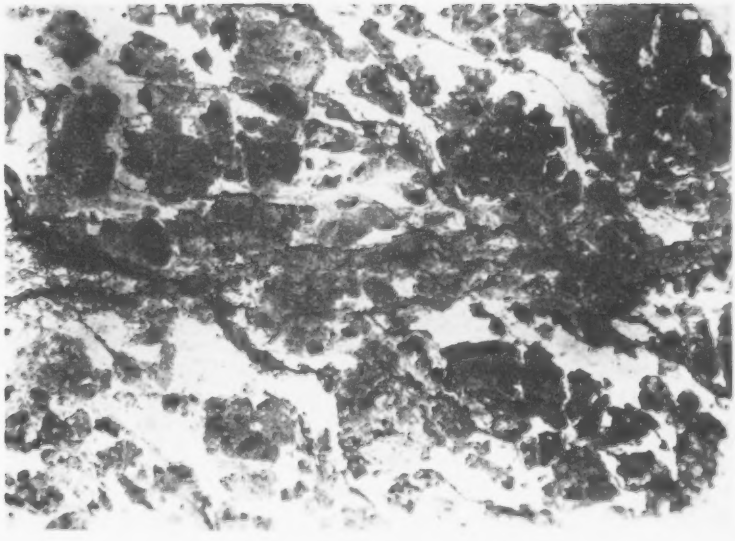

PLATE 7 Photomicrograph of La Reine gneissic granite.

The gneissic granite of the La Reine pluton is typically well foliated with commonly fair to well developed mineral lineation or foliation of dark minerals. The mass as a whole is uniform in character and remarkably free of xenoliths as noted earlier by Cooke (1932). Locally, however, particularly in western sections of the massif, massive unfoliated granite is present, occasionally containing xenoliths. Such material probably represents a later intrusion of granitic material or remobilization of the gneissic granite.

Two typical samples of the La Reine granite were submitted for chemical analysis. The freshest rock came from the north shore of Nepawa bay (No. 30, Table 15) and consisted of a white-weathering, white and black, medium-grained, wavy foliated, gneissic aggregate of quartz, white feldspar and black biotite. Thin-section study reveals an allotriomorphic granular, broadly foliated aggregate of quartz (20%), zoned plagioclase feldspar in varying states of alteration from heavily altered cores to fresh rims (70%), minor amounts of microcline crystals, biotite, some muscovite flakes possibly later than the biotite which defines the gneissosity, epidote and accessory apatite.

The second specimen analyzed came from the northeasternmost portion of the La Reine body in the township in lot 47, range X, and consisted of a white-weathering, pinkish white and streaky green, wavy foliated, medium-grained, more or less equigranular aggregate of quartz, feldspar and chloritized biotite. Examination in thin-section under the microscope reveals a largely allotriomorphic granular gneissic aggregate of quartz (20%), heavily to lightly altered plagioclase feldspar (70%), both fresh and chloritized biotite, apparently later muscovite flakes, some microcline, minor carbonate and accessory apatite and possibly monazite.

Another specimen of gneissic granite from lot 36, range X, examined in thin-section under the microscope, consisted of strongly saussuritized plagioclase, some fresh plagioclase, minor microcline, quartz and strongly oriented biotite, with quite abundant epidote, minor carbonate, and apatite. Muscovite flakes cut across the biotite flakes indicating some post-deformational recrystallization.

Another specimen similarly examined from lot 16, range X, is a variable grey to brownish white weathering, black and white, massive, granitic aggregate with scattered small mafic xenoliths. Under the microscope the rock is an allotriomorphic granular aggregate which shows no preferred orientation and consists of some heavily saussuritized plagioclase, biotite, some muscovite and minor potash feldspar, epidote and apatite. This latter occurrence is distinctly typical of the La Reine mass as a whole and probably represents a later granitic intrusion or a remobilization and recrystallization of a portion of the original gneissic massif and its surrounding country rock.

TABLE 15

Gneissic Granites and Granodiorites

| | 30 | 31 | 32 | 33 |
|---|---|---|---|---|
| $SiO_2$ | 70.04% | 68.76% | 68.70% | 61.74% |
| $TiO_2$ | 0.13 | 0.18 | 0.15 | 0.45 |
| $Al_2O_3$ | 15.35 | 15.02 | 15.90 | 15.52 |
| CaO | 3.64 | 3.32 | 3.71 | 4.36 |
| MgO | 0.27 | 1.02 | 1.40 | 3.52 |
| FeO* | 2.06 | 2.88 | 2.39 | 4.91 |
| $Na_2O$ | 5.00 | 4.70 | 4.75 | 5.00 |
| $K_2O$ | 1.35 | 1.53 | 1.34 | 1.21 |
| V | 0.005 | 0.005 | 0.009 | 0.011 |
| Cr | 0.016 | 0.025 | 0.017 | 0.015 |
| Fe (total) | 1.60 | 2.23 | 1.85 | 3.82 |
| Ni | 22 ppm | 27 ppm | 29 ppm | 82 ppm |
| Cu | 32 " | 46 " | 52 " | 103 " |
| Zn | 40 " | 41 " | 35 " | 84 " |
| Pb | 14 " | 13 " | 18 " | 17 " |

* original determination was for total iron. For purposes of calculation and comparison, total iron has been entirely converted to FeO.

30 La Reine granite from an outcrop on the northern shore of Nepawa bay in lot 27 on the range IX-X line.

31 La Reine granite from an exposure in the north end of lot 47, range X.

32 Nepawa Bridge altered granite from a shore outcrop on the mainland south of Nepawa bridge; lot 32, range IX.

33 Nepawa tonalite from a small island in the northwestern bay at the western end of Nepawa island; lot 5, range IX.

(All analyses by the Laboratories Branch, O.D.N.R.)

A third specimen of granite from a small ill-defined body in amphibolitized greenstones in the vicinity of the bridge onto Nepawa island, was taken for chemical analysis (No. 32, Table 15). It came from a clean shoreline exposure of white-weathering, white and black, distinctly lineated and faintly foliated, equigranular aggregate of clear quartz, white and greyish white feldspars, and chloritic dark minerals (about 10%) with minor epidote present in fine grains. Examination under the microscope reveals a highly altered granitic rock composed of aggregates of crushed quartz masses, heavily saussuritized or sericitized plagioclase feldspars, chlorite and chloritized biotite, with associated fine magnetite grains and some muscovite.

Nepawa Granodiorite or Quartz Diorite

The western end of Nepawa island is occupied by a distinctive buff-weathering, faintly to moderately well-foliated, quartz dioritic or granodioritic rock with local lighter weathering more granitic sections. Contacts with the enclosing amphibolitized and deformed greenstones are generally well defined and sharp but are locally made up of intrusive breccias and minor migmatized zones.

The specimen (No. 33, Table 15) of the Nepawa pluton taken for chemical analysis is a pinkish white to buff weathering, white, light pink and black, very faintly foliated, medium-grained, equigranular aggregate of clear quartz, white and pinkish feldspars, and black amphibole. Viewed in thin-section the rock is a hypidiomorphic granular aggregate of quartz (15%), saussuritized plagioclase (50%) and hornblende (30%), with some chloritized biotite, minor amounts of potash feldspar, and accessory sphene and apatite. The rock is perhaps best designated a tonalite.

## Palmarolle Granite and Related Rocks

The western margin of the Palmarolle granite batholith which occupies most of Palmarolle township crops out in Roquemaure township in the form of a few island outcrops and a narrow band along the eastern side of Indian Cemetery peninsula in the eastern parts of ranges VI and VII. Adjoining the granite proper to the west is a narrow band of migmatites and a distinctive layer of quartz diorite.

The granite exposed along the southern half of the northwestern quarter of the township on the islands of La Sarre bay, is a white-weathering, light grey, medium-grained hypidiomorphic granular aggregate of quartz (15 to 20%), zoned plagioclase (60 to 65%), biotite (8 to 15%) and microcline (1 to 2%), with secondary epidote, chlorite and pyrite and accessory apatite and sphene. On the whole the specimens of granite from more southerly exposures appear fresher than the specimen analyzed (No. 34, Table 16). The cores of feldspars of some specimens are heavily saussuritized and must have been quite calcic originally whereas they possess rims which are clear and probably albitic. The feldspars on the specimen analyzed are somewhat less intensely but overall much more extensively altered so that little, if any, fresh feldspar remains.

The specimen of Palmarolle granite taken for chemical analysis came from an island outcrop on the Palmarolle-Roquemaure boundary in range IX. Here the granite is medium grained, pink and grey in colour, and weathers to a brownish white. It is a tough, hard-to-break rock which consists of an aggregate of quartz, pink feldspar, occasional red feldspar, epidote grains, and about 5% green chloritic shredded mafic matter. Under the microscope this rock is seen to be an allotriomorphic granular aggregate rather uneven in grain size, made up of anhedral inequigranular quartz (20%), 70% of altered zoned plagioclase ($An_{35}$ or less), and altered amphibole and chloritized biotite (these mafic minerals and their alteration products make up about 10% of the rock), with minor myrmekite, accessory sphene and apatite. Chlorite, epidote, sericite, pyrite, and magnetite are secondary.

The specimen of quartz diorite which appears to form an aureole around the Palmarolle batholith at the north end of Indian Cemetery peninsula is a distinctive black-speckled, reddish brown weathering, black,

green, and white, medium-grained equigranular aggregate of quartz, light green feldspar grains with blurred outlines, and scattered elongate amphiboles. Under the microscope the rock is seen to consist of about equal amounts of hornblende and strongly saussuritized plagioclase with approximately 10% quartz in granular mosaics and chlorite, epidote, carbonate, apatite and magnetite. A few flakes of biotite are present but they are for the most part chloritized.

TABLE 16

Palmarolle Granite and Granodiorite

| | 34 | O | P | Q |
|---|---|---|---|---|
| $SiO_2$ | 71.90% | 69.30% | 68.47% | 73.20% |
| $TiO_2$ | 0.08 | 0.23 | 0.53 | 0.34 |
| $Al_2O_3$ | 14.32 | 16.81 | 12.98 | 13.07 |
| $Fe_2O_3$ | - | 0.28 | 1.19 | 0.64 |
| FeO* | 1.65* | 1.26 | 4.69 | 2.44 |
| MnO | - | trace | - | - |
| MgO | 0.27 | 1.08 | 2.06 | 0.72 |
| CaO | 1.54 | 3.34 | 4.51 | 2.26 |
| $Na_2O$ | 5.05 | 6.00 | 3.13 | 3.63 |
| $K_2O$ | 2.78 | 1.39 | 0.64 | 2.33 |
| $H_2O$ | - | 0.50 | 1.30 | 0.80 |
| $P_2O_5$ | - | 0.03 | 0.18 | 0.12 |
| $CO_2$ | - | 0.15 | nil | nil |
| Fe(total) | 1.28 | | | |
| TOTAL | | 100.37 | 100.10 | 100.06 |
| V | 0.005 | | | |
| Cr | 0.008 | | | |
| Ni | 19 ppm | | | |
| Cu | 32 " | | | |
| Zn | 21 " | | | |
| Pb | 18 " | | | |

* original determination was for total iron. For purposes of calculation and comparison total iron has been entirely converted to FeO.

34 Palmarolle granite island outcrop, range IX, on Roquemaure-Palmarolle township boundary. Analysis by the Labratory Branch, Q.D.N.R.

O Trondjhemite, Trondjhem, Norway (Goldschmidt, 1916, p. 75)

P Biotite-bearing hornblende tonalite border facies of Palmarolle mass: range II, lot 38, Palmarolle township (Faessler, 1962, p. 66).

Q Biotite leucogranodiorite, core facies of Palmarolle mass: Poularies twp., range IV, lot 16 (Faessler, 1962, p. 67).

A chemical analysis of this rock is given in Table 17. The La Reine, Nepawa, and Palmarolle granitic rocks appear to be quite similar chemically, and their distinctive field character may be largely due to varying degrees of deformation, recrystallization and/or remobilization.

## Lamprophyre Dikes

Thin lamprophyre dikes occur in several widespread localities; they are probably not more evident because they erode much more easily than their enclosing country rock. A 5-foot wide biotite lamprophyre dike occurs near the main asbestos showings of range I. An 18-inch sill of muscovite lamprophyre occurs within a 4-foot layer of chert in massive basalt in lot 33, range I, according to Lee (1950).

Two east-west dikes, 6 inches to 1 foot wide, cut rhyolitic lavas and rhyolite porphyry in lot 54, range V. Another 4-inch dike near the range IV-V road in lot 52, range IV, is a light grey weathering, grey, fine-grained, highly altered aggregate of large carbonate grains, chlorite flakes and chloritized biotite in a fine-grained highly altered groundmass.

## Late Diabase Dikes

Both porphyritic and non-porphyritic varieties of diabase dikes occur in small numbers throughout the township, generally with northerly to northeasterly trends and vertical to near vertical dips. Quantitatively they are of minor importance.

The porphyritic variety of diabase is very much less abundant than the non-porphyritic species and has been noted in only two localities. In both cases the porphyritic dikes parallel non-porphyritic diabase dikes; no relative age relationships could be established at either locality.

TABLE 17

Palmarolle Diorite

| | 35 |
|---|---|
| $SiO_2$ | 56.81% |
| $TiO_2$ | 1.00 |
| $Al_2O_3$ | 16.59 |
| CaO | 6.43 |
| MgO | 2.74 |
| FeO* | 7.91 |
| $Na_2O$ | 3.56 |
| $K_2O$ | 1.12 |
| V | 0.016 |
| Cr | 0.006 |
| Fe(total) | 6.13 |
| Ni | 55 ppm |
| Cu | 41 " |
| Zn | 50 " |
| Pb | 16 " |

* original determination was for total iron. For purposes of calculation and comparison, total iron has been entirely converted to FeO.

35 Palmarolle quartz diorite from the shoreline at the north end of Indian Cemetery peninsula.

A porphyritic diabase dike in lot 28, range I, is a brown-weathering, "salt and pepper" white and green, medium-grained aggregate containing about 20% large (1 to 2 cm.) feldspar phenocrysts and scarce grains of pyrite. A thin-section of this rock reveals heavily saussuritized plagioclase phenocrysts set in a sub-ophitic hypidiomorphic granular groundmass of clinopyroxene (40%), heavily saussuritized plagioclase (45%), minor chlorite (3 to 4%), and quartz (1 to 2%) and very minor carbonate and accessory apatite.

A similar porphyritic diabase occurs in lot 46, range X, as a 10-foot wide, quartz diabase dike trending N.5°E.

The more widespread non-porphyritic diabase dikes are typical of the late diabase dikes to be found throughout the Superior Province of northwestern Quebec and generally referred to as Keweenawan in age, although many are older than the Keweenawan. The typical diabase in Roquemaure township is a dark brown weathering, dark green to black, medium-grained rock with small amounts of accessory sulphides. One specimen analyzed (No. 36, Table 18), was found by examination under the microscope to be a hypidiomorphic granular aggregate with an ophitic texture composed of augite (50%), fresh to slightly altered labradorite (40 to 45%), magnetite and pyrite (4 to 5%), micrographic intergrowths of quartz (1 to 2%) with minor chlorite, epidote and apatite. The rock is a quartz diabase of tholeiitic affinities. The analysis of a diabase dike from Rankin township, Ontario is presented for comparison.

TABLE 18

Late Diabase

| | 36 | R |
|---|---|---|
| $SiO_2$ | 48.52% | 50.76% |
| $TiO_2$ | 1.08 | 1.50 |
| $Al_2O_3$ | 12.85 | 13.90 |
| CaO | 10.56 | 8.14 |
| MgO | 6.45 | 4.73 |
| FeO | 14.40* | 10.28 |
| $Fe_2O_3$ | - | 4.17 |
| $Na_2O$ | 2.24 | 2.82 |
| $K_2O$ | 0.41 | 0.85 |
| V | 0.032 | |
| Cr | 0.025 | |
| Fe (total) | 11.16 | |
| Ni | 94 ppm | |
| Cu | 188 " | |
| Zn | 110 " | |
| Pb | 22 " | |

* original determination was for total iron. For purposes of calculation and comparison, total iron has been entirely converted to FeO.

36 Quartz diabase dike: lot 47, range X at the north end of lot on the Roquemaure - La Peine township boundary. Sample taken from forty-foot wide dike striking N.5°E., dip vertical, cutting gneissic granite.

R Diabase dike: Rankin twp., Timiskaming district, Ontario (Maxwell et al., 1965, p. 77).

## STRUCTURAL GEOLOGY

In northwestern Quebec, most of the various rhyolitic and basaltic lava formations have, through folding, been stood on end with regard to their original horizontality, and yet their primary structures, large and small pillows, flow layering, flow contacts, etc., and their primary textures: porphyritic, amygdaloidal, spherulitic, etc., are from the most part perfectly preserved. This preservation from deformation and the low grade of metamorphism represent anomalies difficult to explain, for the Archean units have indeed been strongly folded, often isoclinally and supposedly represent the "roots" of great mountain chains. The student of volcano structures, in fact, can often better see them displayed in the Archean bedrock of Quebec than he can in much less deformed volcanic accumulations of late age or even around recent volcanoes. Anhausser et al. (1968) suggest that the Archean segments of all the Precambrian shields of the world may represent a suite of rocks formed and deformed during a time of special conditions in which normal mountain building deformative processes were not operative.

### Major Trends and Structures

Two major trends dominate the structure of the bedrock of the township which the outcrop bands of basaltic volcanic rocks largely delineate. In the southern half of the township the dominant trend is in a N.70°W. direction with the notable exceptions of the Roquemaure quartz gabbro pluton which trends east-west, and the contact between the basaltic and rhyolitic outcrop bands which appears to trend about N.55°W. In the eastern central section of rhyolitic and numerous salic dikes (rhyolite complex) a strong secondary trend of N.30°W. overprints earlier deformational trends.

In the northern half of the township the bedrock structures trend about N.55°E. but with local deviations reflecting the shapes of La Reine and Nepawa island plutons. Contacts and structures of the Palmarolle granite and parts of the Nepawa granodiorite strongly define other northerly to north-northwesterly trends. Second cleavages and folding in the already deformed volcanic rocks also reflected this trend. The N.55°E. trend appears from an inspection of regional maps (Dugas, Latulippe, Duquette, 1967) to be exceptional; it is apparently truncated or deflected in nearby townships to the northeast.

Cross-faults trending northerly are common small scale structures to be seen in outcrop throughout the area, and are probably major structural elements on a broader scale.

The basalts are well pillowed throughout: in the southern half except for minor folds all facings are to the south or southwest; in the northern half many of the pillows have been deformed by "stretching", or "flattening" but sufficient numbers remain undeformed to indicate a major north-northwesterly facing. The basalt bands therefore define a major anticlinal fold closing to the west with the basalts overlying a core of rhyolitic rocks.

Water or clays cover the outcrop area of the nose of this fold where it should occur in the western section of range V, and nothing is known of the fold's hinge or plunge. A strong zone of schistosity developed in the rhyolites to the east in range VI strikes into this covered hinge zone and must intersect it, and possibly disrupts it. This zone of marked schistosity developed in the rhyolitic rocks along the south shore of Lake Abitibi and on nearby islands in the western half of range V and extending northeasterly into range VII represents a major tectonic feature. Within this zone schistosities not uncommonly dip as low as 35 degrees to the northwest. The zone may represent an overthrust fault zone; it has been deformed by later north-trending cleavage, and locally abnormal trends are accompanied on a small scale by well developed cleavage mullions.

The structure of the anticlinal core of rhyolitic lavas and salic intrusive bodies is both complex and varied, and in general is anomalous in local trends relative to those in the adjoining basaltic lavas where the structure is generally much simpler.

Because of numerous dikes and sills of various rocks, and because of faulting, an estimate of stratigraphic thickness of the basalts and rhyolites cannot be made.

Later northerly trending folds, faults, and cleavages disrupt, on a small scale at least within the township, the east-northeast to northeast trending mass of La Reine granite and its enveloping mass of deformed and amphibolitized basalts and mafic intrusions.

## Folding

The major anticlinal structure has already been briefly described. It appears to be strongly disrupted to the east by the Palmarolle granite pluton and on its northern flank by other smaller granitic bodies and a second stage of folding. The southern flank more or less parallels in trend the regional structure and appears to be part of the major Duparquet synclinorium from which, however, it is separated by the Porcupine-Destor "Break". The northern flank, on the other hand, is highly divergent from the regional trend and the earlier 1 mile to 1 inch mapping indicates that it may be radically truncated in the adjoining townships of La Reine, La Sarre, and Palmarolle, by a strong southeasterly band of sedimentary rocks.

In the pillowed basalts of the southern half of the township pillow trends and facings are generally constant, but locally marked changes in trends and facing occur without any other evidence of deformation. One such abnormality indicates a synclinal structure trending northwesterly in the western end of range II. Less well-defined deviations from the general trend occur through the basaltic lavas to the east of this occurrence.

In the northern half of the township the pillowed basalts are weakly to strongly amphibolitized and often strongly "stretched", "elongated", or "flattened" in a manner such that the lengths of their pillows have become many times longer than originally, whereas pillow thicknesses of a foot or more have been reduced to inches. In extreme cases of such distortion of the pillows, particularly in poor exposures, the rock appears well banded and at least superficially tuffaceous in origin. Weak to strong schistosities and lineations accompany this deformation of the pillows. There appears to be no correlation between degree of amphibolitization and the geometric deformation; the former apparently is later than the latter.

In many outcrops in the northern half of the township refolded folds and a second set of cleavages and schistosities, with northerly trends and associated northerly plunging lineations, can be discerned disrupting the general sweep of structures around and parallel to the main contacts and overall structural trends of the La Reine granite pluton. This stock of gneissic granite has a northeasterly trend which runs strongly counter to the general west-northwesterly regional trends, and more locally a strong northwesterly trend revealed by a band of sedimentary rocks running across Palmarolle, La Sarre, and La Reine townships. The La Reine gneissosity appears to be the earlier; the second set of folds and schistosities reflect its deformation by the later folding along northwesterly and west-northwesterly directions.

## Faulting

Concrete evidence for major faulting is scant: the most clear-cut zone of schistosity trends N.55$^{O}$ to 60$^{O}$E. with northerly dips of 35 to 70 degrees across Lac Abitibi from the west end of the range V-VII line. This zone of schist probably represents a major fault structure, possibly a folded thrust fault. On the basis of the indications of earlier mapping, it is cut off or deflected by later structures trending across La Reine, La Sarre, and Palmarolle townships. It is deformed, disrupted, and metamorphosed by later tectonic events.

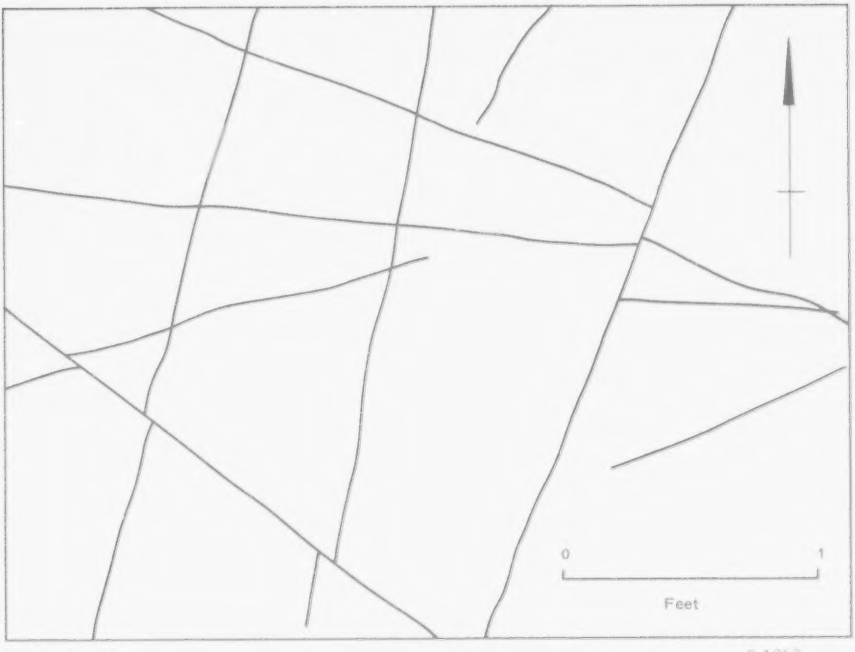


Fig. 7 Numerous small quartz-filled faults and fractures in massive gabbro; drawn from a photograph of an outcrop in the north half of lot 42, range III. Most of the fractures are steep to vertically dipping; a few are gently dipping.

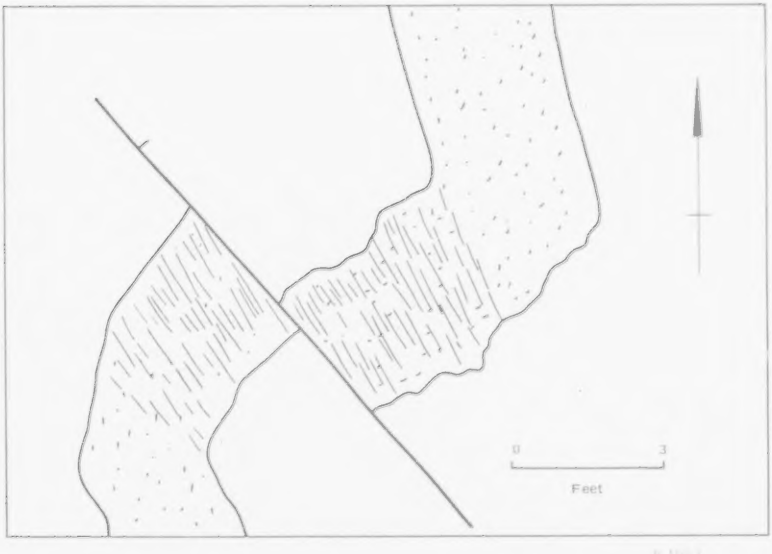


Fig. 8 Folded and faulted porphyry dike in rhyolite; exposure, south half lot 48, range V.

Strike or bedding faults or schist zones do not crop out but undoubtedly exist in considerable numbers. The pattern of north-northeasterly and north-northwesterly faults, shown on the map, are largely conjectural in position, but the existence of such faults is supported by the presence, in most exposures, of many small-scale faults with similar trends and the evidence of physiographic features. Lee (1951) shows a similar pattern of faults on his map of Palmarolle and Poularies townships on regional strike to the east about 10 miles.

Fine Fracturing and Faulting. The gabbroic rocks in particular seem deceptively massive in outcrop, and appear to be largely undeformed excepting for some obvious schist zones, which when seen in exceptional exposures such as along shore lines, are from a foot or so wide to several tens of feet across. Close examination, particularly of burnt-over or otherwise very clean outcrop surfaces, reveals that a myriad of tiny fractures and narrow (0.1 to 1 cm; rarely 2 to 3 cm) quartz-filled stringers, a few centimeters to ten centimeters apart, with various orientations and attitudes, intersect the apparently massive rock. Some of the quartz-filled fractures offset others and represent small faults. Other short, stubby quartz-filled veinlets in échelon arrangement equally clearly represent extension fractures associated with local fault movements.

These observations reveal that the "massive" gabbro bodies are in reality strongly deformed by fracturing and small-scale faulting, and may well have been rotated through 90 degrees or more from their original positions of emplacement by movements along these fractures and small-scale faults without the expected development of more penetrative fracture cleavages or schistosities.

Hairline fractures, quartz veinlets, and small-scale faults are also present in the volcanic rocks, but are usually not as well exposed because of the weathering and erosional characteristics of these rocks. In clean exposures, however, they appear to be equally as abundant as in the "massive" gabbroic rocks and seem to play an equally prime role in their deformation.

Folding appears to have been accomplished in this part of the Archean by irregular fracturing and small-scale faulting accompanied by major movements along relatively widely spaced bedding fault or schist zones, rather than by the development of penetrative shear or slip planes, which often effectively destroy, or strongly modify, the primary fabric of the rocks in which they occur.

The volcanic bedrock of Nepawa island and the northeastern quarter of the township are regionally exceptional: penetrative schistosities and lineations are well developed, and reflect similar structures in the adjoining La Reine, Nepawa bridge and Nepawa island granodioritic and granitic bodies. Indeed, penetrative structures in all these rocks have themselves been deformed by later penetrative structures in a convincing example

of double deformation. The northern half of Roquemaure is, however, the exception which proves the rule on a regional basis. The southern half of the township is underlain by volcanic rocks turned on end, or even overturned to the south, without evidence of penetrative disruption – only a vague fracturing in all directions, accompanied by quartz-filling on a small scale, appears to have taken place to accomplish the deformation, along with bedding faulting.

## Intrusive Relationships

Generally speaking where exposures are good the contacts of small intrusive bodies are blocky and irregular in configuration. These bodies appear to have been intruded into highly jointed or fractured rocks and, in contrast to the generally smooth trends of the late diabase dikes, their contacts are locally highly variable in trend, and often difficult to trace for any distance. Many of their contacts and trends have been further complicated by local faulting.

As noted earlier in the section on intrusive rocks, many of the larger dioritic and gabbroic bodies do not exhibit clear-cut contact relationships. Xenoliths of various lava types up to several tens of feet across and hundreds of feet long are not uncommon, and smaller xenoliths are commonplace.

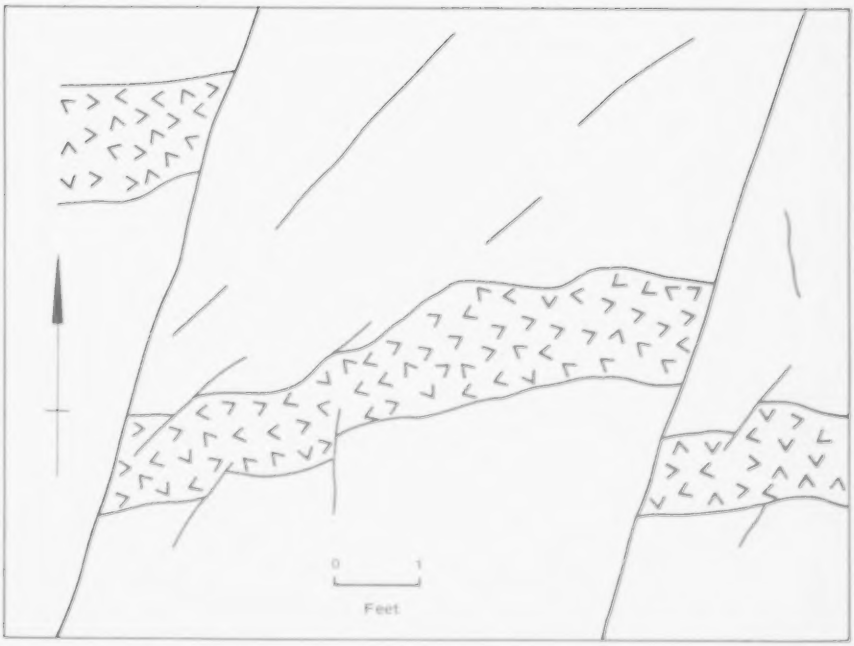


Fig. 9 Repeatedly faulted small basic dike intruding rhyolite breccia in a blocky manner (drawn from sketches and photographs of an outcrop in lot 22, range V).

## METAMORPHISM

Many if not most of the supracrustal rocks, that is the salic and mafic volcanic rocks, show relatively scant metamorphism. Indeed, many of the volcanic rocks have scarcely been affected beyond the stage of devitrification, and are almost as "fresh" as much more recent lava flows. A pervasive regional metamorphism to the mild greenschist assemblage of minerals prevails throughout with the development of secondary quartz, albite, chlorite, white mica, carbonate, etc.

Only in the aureoles of the La Reine granite, the Palmarolle granite, and the Nepawa granite and granodiorite bodies are higher grades of metamorphic rocks encountered, and for the most part in the higher greenschist and lower epidote amphibolite facies; generally the metamorphic zones are poorly developed, except within a few hundreds, and more rarely thousands, of feet from the granitic contacts. Only in the northwestern corner of the township has a clear-cut albite-amphibolite facies been developed in the country rocks, and here, unfortunately, the exposures consist of only a few scattered island outcrops.

The pervasive low-grade metamorphism is responsible for a strong tendency towards a mineralogical convergence which makes the distinction of field units difficult, particularly in the field. This metamorphism is accompanied by little or no deformation and the primary fabric of the rock is often preserved or only slightly disturbed so that a weak prefered orientation of mineral develops.

In the northern three ranges of the township, however, in the mafic volcanic formations around the La Reine and Nepawa granitic bodies, and to a lesser extent in the aureole of the Palmarolle batholith exposed along the western shores of the Indian Cemetery peninsula, an amphibolite facies is prominently developed. The amphibolitization is by no means pervasive or uniform and cannot be properly delineated upon the map. Strong zones appear to be haphazard within the aureoles of the granitic bodies and may well reflect a somewhat later thermal event than at least some of the granite intrusions themselves represent. The La Reine granite and its satellites reveal on close study that they have been deformed and metamorphosed and that they may cause little contact metamorphism in their enclosing lavas.

### Amphibolitization

The pillowed basalts in the amphibolite zone of Nepawa island show great variability both as regards degree of deformation and degree of amphibolitization. No pattern of development of either intense deformation or intense amphibolitization was revealed by the mapping, nor

was any relationship between the two phenomena clearly discernible. Pillows may appear strongly flattened and but weakly or very finely amphibolitized, and vice versa.

Typical stretched or flattened pillows occur in several exposures and road cuts in lot 15, range VIII and a specimen (No. 8, Table 4) was chosen for chemical analysis. The material collected included all portions of the rock, not a pillow interior alone. In hand specimen the rock is a brown-weathering, dark green, very fine grained, finely lineated aggregate with some scattered fine pyrite grains. It is made up essentially of pleochroic green hornblende with albite and quartz, abundant epidote and scattered relatively large magnetite grains. The chemical analysis reveals a composition of that of a tholeiitic basalt.

A typical amphibolitized but only slightly deformed pillowed basalt is well exposed in a shore line exposure on the north side of Nepawa island in lot 22, range IX. A sample for chemical analysis (No. 4, Table 4) was taken from a single pillow centre. The rock is a brown to pale green weathering, green, fine-grained aggregate of colourless to faintly pleochroic actinolite with minor sphene and some chlorite. It is very faintly foliated. Chemical analysis reveals an original composition of that of a picritic or very olivine-rich basalt. Another specimen from the same locality is, under the microscope, an equigranular, granoblastic aggregate almost entirely composed of weakly pleochroic, colourless to pale green actinolite with scattered sphene (about 2 to 3%) and minor plagioclase. These rocks are the amphibolitized equivalents of the southern picritic basalts; they exhibit serpentine pseudomorphs after olivine and fine plagioclase crystallites, all evidence of their original volcanic texture.

Gabbroic intrusive bodies occur with the basalts on Nepawa island and some sections of these bodies have been strongly amphibolitized and otherwise altered by shearing. Many small exposures of amphibolite are of undetermined origin -- they may represent highly metamorphosed basalts in which the pillow structure has been destroyed completely or amphibolitized gabbros.

Several excellent exposures of amphibolite exist in lot 30, range VIII, on the south shore of Nepawa island. One exposure consists of a strongly lineated to unoriented aggregate of black amphibole needles in a dark greyish green to black, medium-grained groundmass which weathers to a black speckled, greenish grey, rough surface. A specimen taken for chemical analysis (No. 25, Table 12) reveals a granular, allotriomorphic, crudely layered schistose aggregate containing large poikiloblastic hornblende crystals. The matrix appears to have been derived by the crushing and alteration of feldspars to secondary quartz, chlorite and epidote; only a little feldspar is left in a chloritic matrix.

On Indian Cemetery peninsula is a greyish fawn weathering, greyish black, very fine grained, seriate, feldspar porphyry with white

feldspar phenocrysts ranging in size from 1 to 5 mm. Under the microscope it is seen to consist of heavily altered feldspar phenocrysts, some with poorly developed quartz "shadows", set in a fine-grained schistose aggregate of amphibole, quartz, epidote, and magnetite.

Rocks of the albite amphibolite facies, the highest grade of metamorphism to be identified in the township, crop out as small islands or reefs in the northwestern corner of the township. One small island is largely composed of a brown-weathering, sparkling black, schistose aggregate containing scattered small (1 to 2 mm.) white feldspar grains. Under the microscope the rock is seen to be composed of a strongly foliated granoblastic aggregate of strongly pleochroic amphibole (40%), quartz, and albite with some highly altered, partially rotated, remnants of plagioclase (about 10%). Magnetite is an accessory mineral. Generally the mineral grains have clear-cut contacts with their neighbours and are "fresh" in appearance in contrast to the minerals of most thin-sections cut from rocks from the township; all in all, the make-up of this rock is in strong contrast with the vast majority of rock types which show partially altered minerals and vaguely defined grain boundaries.

On a nearby reef a brown-weathering, dark green, fine-grained, strongly lineated schist is seen under the microscope to be a poorly layered, granoblastic aggregate of strongly pleochroic amphibole (65%) showing a marked preferred orientation, quartz, and albite with minor saussuritized calcic feldspar, sphene, and scant magnetite.

## Evidence of Multiple Metamorphism

Much evidence points to the fact that the lavas and the La Reine granite were caught up in an intense episode of dynamic metamorphism. This was followed by a later, areally more poorly developed, thermal metamorphism accompanying a second period of deformation, responsible for the folding of earlier-formed penetrative schistosities, lineations, and small scale folds.

Metamorphic evidence of a second deformation of the northeasterly trending schist zone is provided by the microscopic examination of a specimen of schistose rhyolite from a small low island outcrop in lot 24, range VI, in the southern half of Lake Abitibi. The rock underlying the island, except for a small amount of green chloritic schist on its northwestern side, is a light fawn weathering, dark olive green, very fine grained schist or phyllite with scattered tiny white feldspar phenocrysts and minute greenish black mafic streaks. The schistosity and a mineral lineation are quite evident in the exposure, but the rock does not break readily along its schistosity. Microscopic examination reveals a very fine grained schistose aggregate of quartz, white mica, carbonate, chlorite, minor potash feldspar and magnetite, with fairly well preserved oligoclase phenocrysts and scattered biotite as flakes or small concentrations. The biotite

is later than the penetrative schistosity and its associated greenschist minerals, and cuts across them, destroying parting properties of the rock.

An unusual rhyolitic rock crops out as a tiny reef in lots 29 and 30, range VI, in Lake Abitibi. It is white-weathering, black in colour, very fine grained, and slightly porphyritic; it is very hard and possesses a distinctly conchoidal fracture. The exposure lies in the north-easterly trending schistose rhyolite belt and an irregular fracture cleavage, trending east and dipping 50 degrees north, is present. A suspected siliceous composition is not supported by microscopic examination: the rock is composed of altered but definite small phenocrysts of plagioclase and occasional relatively large aggregates of quartz, or quartz, chlorite and carbonate, in a very fine grained equigranular groundmass of the same minerals, with a few scattered grains of magnetite. The rock, which was probably originally a rhyolitic lava, or related intrusive rock, appears to have been broken up by deformation, followed by chloritization without the development of a schistosity but only a more widely spaced fracture cleavage.

A few lots to the east, in lot 32, range VI, a greenish fawn weathering, greenish grey, very fine grained, schistose feldspar porphyry crops out, as a nearly submerged reef, in the same general schistose rhyolite zone. Here, however, the schistosity, which is quite distinctive, trends S.40°E. and dips 40 degrees to the northeast. This rock contains abundant sericitized oligoclase phenocrysts and occasional quartz "eyes" in a fine groundmass of quartz, plagioclase and green chlorite, with numerous scattered grains of ankeritic carbonate. This rock was probably originally dacitic in composition.

## GEOLOGICAL HISTORY

The paucity of outcrop coupled with the many and varied lithological types, often within bodies of small dimensions and indeterminate trends, make it difficult to define the geological history of Roquemaure township with any precision. In broad terms, it appears to have been as follows:

1 - submarine extrusion of rhyolitic and dacitic lavas, along with some andesites, to form a major volcanic mass or pile of salic material, possibly with rubbly slopes of 10 to 20 degrees or more, and the intrusion into this purely extrusive igneous material of a variety of compositionally related, penecontemporaneous dikes and sills;

2 - a transitional period of volcanism during which time mafic lavas flowed aside and over the earlier salic extrusions, resulting in a zone of volcanic rocks of mixed composition, e.g. rhyolitic fragments in a mafic lava matrix — in one case, a block of rhyolite 10 feet by 5 feet was observed in such a breccia;

3 - a major period of submarine basaltic volcanism producing a thick accumulation of pillowed lavas, probably as "flood" basalt, intruded by compositionally related sills. Occasional thin layers of tuffs or brightly coloured cherts were laid down between flows, along with some minor products of rhyolitic volcanism. The emplacement of the range I peridotite bodies probably took place at this time;

4 - a first period of major folding accompanied by faulting and further intrusion by intermediate to basic igneous bodies, culminated in the emplacement of the northern La Reine granite; the greenschist facies of metamorphism was probably established throughout the volcanic rocks at this time;

5 - a second phase of folding, affecting, for the most part, the rocks of the northern half of the township; faulting and the intrusion of the Nepawa granodiorite and granite, and the Palmarolle granite;

6 - intrusion of late salic and mafic dikes and further faulting;

7 - intrusion of north-trending diabase dikes, possibly of two ages: an earlier porphyritic variety and a later, typically Keweenawan type.

## ECONOMIC GEOLOGY

The large outcrops which protrude through the clay blanket of postglacial Lake Barlow-Ojibway have obviously been carefully prospected, most probably for gold; disseminated sulphides along minor fractures and narrow schist zones, particularly in rhyolitic rocks, have been stripped, sampled, and occasionally trenched. This activity was probably carried out during the 1930's, before the township was extensively cleared for farming.

From evidence in the field, and from the date available in the assessment files of the Department of Natural Resources, little exploration on the ground has taken place in the township since the end of World War II, particularly in the search for base metal deposits. The most important exploratory work was carried out in the eastern half of range I, to investigate several showings of chrysotile asbestos. A staking rush, followed by exploratory work, resulted from a silver discovery in lot 43, range IX. A number of geophysical surveys of various types have been made in other sections apparently without encouraging results.

Asbestos Occurrences

An asbestos-bearing peridotitic zone in the southern half of the eastern third of range I was explored by Quebec Asbestos Corporation in 1950, and subsequently by the Canadian Johns-Manville Co., Ltd., in 1962. The zone in Roquemaure and adjoining Hébécourt township was geologically and geomagnetically surveyed and probed by diamond drilling. This zone is of complex geology; it occupies the rugged flank of the main south township boundary ridge in a section of abundant second growth scrub bush. The sparsely distributed, good quality chrysotile asbestos veinlets, which average about 5 mm. in width, with occasional 1 cm. veinlets, occur in moderately to strongly fractured and serpentinized peridotite and dunite, along with veinlets of pale green serpentine and carbonate.

Silver Mineralization

The discovery of silver mineralization in a water well drilled by the Department of Agriculture and Colonization, in lot 43 of range IX, sparked considerable, if brief, interest in the township. Area Mines Limited, after extensive geological and geophysical surveys, drilled some eight holes in a restricted area near the original discovery. Only one significantly high assay for silver (64 oz. Ag per ton) was encountered in one hole over an intersection of 1 foot. This mineralization occurs in the deformed and metamorphosed aureole of the La Reine granite, developed in basaltic lavas with minor associated layers of salic and mafic tuffs, near a major north-trending diabase dike (Keweenawan age?). The mineralization may be related to the diabase dike.

Copper Mineralization

Although the experience in metallic mineral exploration has not been encouraging, the township is underlain by a major basalt-rhyolite contact, extending from the southeast corner of the township in range I to the western part of range V. The acidic-basic lava contacts are considered important in exploration to the south in the Noranda area, some 20 miles away.

Some copper mineralization has been discovered near this basalt-rhyolite contact in two places:

1 - at the north end of lot 6, range II, minor amounts of disseminated pyrite and chalcopyrite occur in a trench in massive gabbro:

2 - in lot 57, range II, a water well drilled by the Department of Agriculture and Colonization encountered 0.18% copper as chalcopyrite over an intersection of 2 feet in rhyolite breccia.

It must be emphasized that the general sparseness of exposures, coupled with the presence of an overburden of glacial lake clays

and till of varying and probably locally considerable thickness (possibly several hundreds of feet), make exploration difficult even with geophysical methods.

Copper-sulphide bearing float has been reported from the shores of the main bay at the western end of Nepawa island.

Puzzingly high trace contents of copper and to a lesser extent zinc and lead, occur in a number of supposedly unmineralized rock specimens submitted for analysis, the results of which are embodied in earlier sections of this report.

Potential for Nickel Mineralization

The significance to prospecting of the presence of ultramafic pillow lavas, as well as serpentinized peridotite-dunite bodies, containing high trace contents of nickel is difficult to evaluate with the information presently at hand, and the state of knowledge concerning the genesis of nickel sulphide deposits.

Tentatively it might be concluded that Roquemaure township lies in part of a geochemical Province different from that to the south, which contains the copper deposits of the Noranda region, and that it may be favorable for nickel or copper-nickel deposits. The high trace nickel values are obviously bound in with the magnesium-bearing silicate minerals in the specimens analyzed, but elsewhere, in unexposed areas, nickel may have moved into sulphide concentrations, or be present as original nickel sulphide concentrations.

Nickel deposits occur in genetically related intrusive ultramafic rocks eighty miles to the west of Roquemaure township in the Timmins-Matheson area of Ontario. Nickel ore at the Marbridge mine has been exploited north of the town of Malartic in La Motte township, fifty miles to the east-southeast of Roquemaure township. In the intervening area, between the township and the La Motte ore occurrences, are several small ultramafic intrusions in mafic lavas of undetermined chemical and mineralogical composition. The results of the present study can be stated quite simply: the township may belong within a nickel geochemical sub-province of northwestern Quebec and northeastern Ontario which is favorable for nickel deposits.

MacLean (1969) proposes two models for the genesis of magmatic nickel sulphide ore deposits. The first model involves an emanation of nickel sulphide liquid directly from the mantle in equilibrium with basaltic or ultramafic magmas. His second model envisions oxidation of nickel-bearing silicate magma which releases nickel as an immiscible nickel sulphide liquid, which settles to the base of an ultramafic intrusion. In this last model oxidation could occur either within the magma chamber or in the conduit as the magma rises towards the surface.

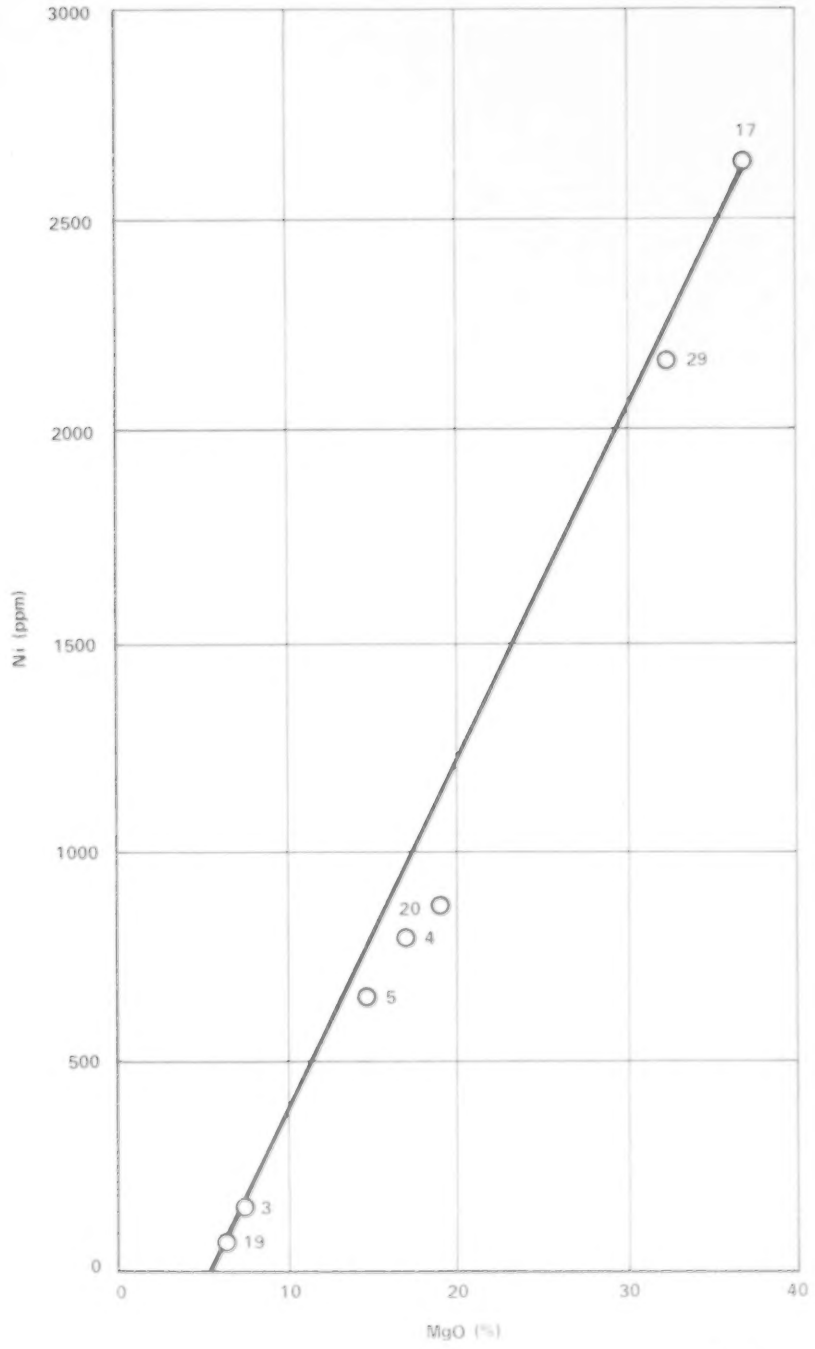


Fig. 10 - Plot of MgO - Ni in basalts and ultramafic intrusive rocks.

Naldrett (1966), on the other hand, has proposed a different conceptual model to explain the occurrence of nickel sulphide bodies associated with ultramafic intrusive bodies of the Timmins-Matheson area, including those of the Alexo mine. He envisions the introduction of sulphur into either a consolidated or partially consolidated peridotite mass in such a manner that the sulphur can react with the nickel and iron contained in the silicate minerals to form nickel and iron sulphides, which under favourable conditions can migrate and concentrate to form economic deposits.

Sand and Gravel

A number of sand and gravel pits provide adequate supplies of road building and maintenance material for local needs.

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